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The Welding Engineer

Edited by L. B. Mackenzie

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See "Torches"

BOOKS (Relating to Welding)
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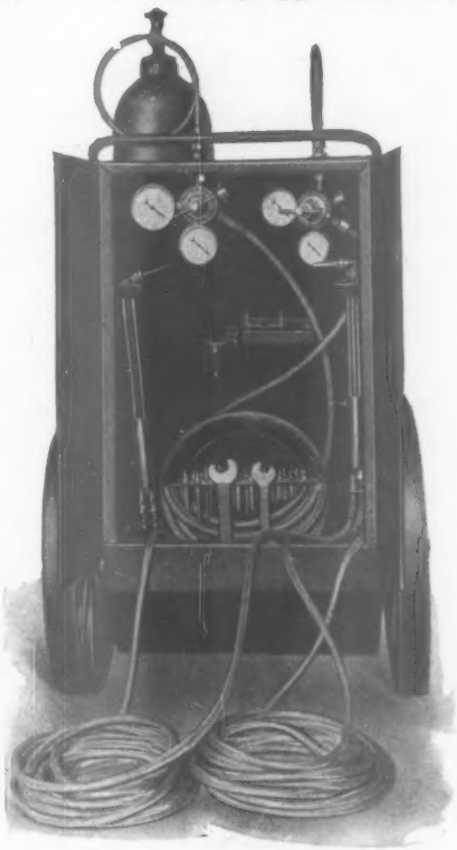
The truck is of all-steel welded construction, combining a steel cabinet or locker with two folding doors and platform for cylinders, mounted on two wide tired wheels of 30-inch diameter. Complete welding and cutting outfit is contained within the cabinet, the regulating valves in fixed position, attached to inside top of cabinet, and in full view of operator. Connections from regulators to oxygen and acetylene tanks are made with ¼-inch seamless brass coils. Illustration shows truck with doors open, and ready for use.



The cylinders are held firmly in upright position by chains which are drawn tight by means of eye-bolts and wing nuts inside the cabinet. All danger of cylinders being tipped over and regulators attached to cylinders being broken, is done away with. There is ample space in the cabinet for welding supplies and accessories. When through work, the operator hangs the torch in the cabinet, closes the cylinder valves, and locks the cabinet doors. The truck may be left on the job, with assurance that all adjustments and connections will be found as they were left, when the operator returns to work.

Write for Bulletin 507, illustrating cabinet trucks and other portable outfits.

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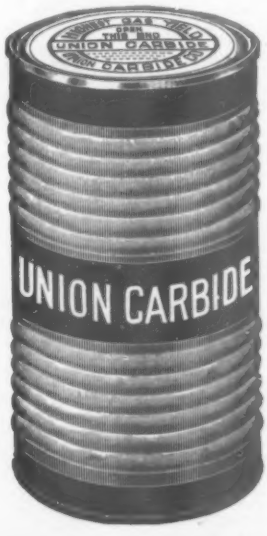

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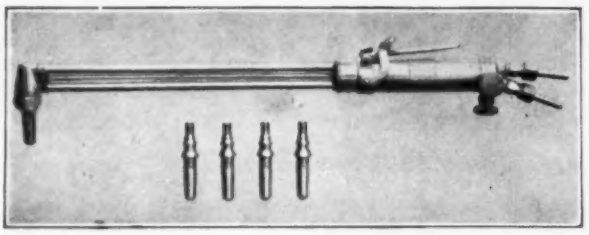

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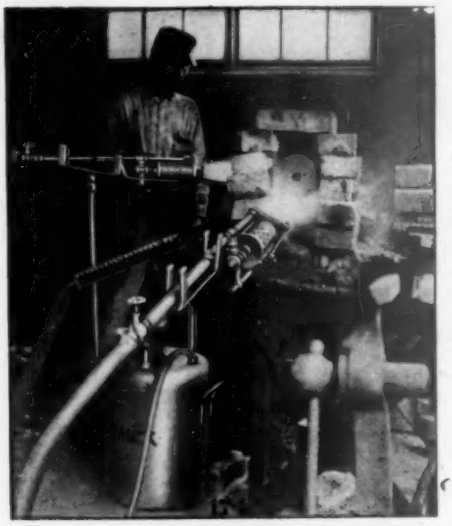

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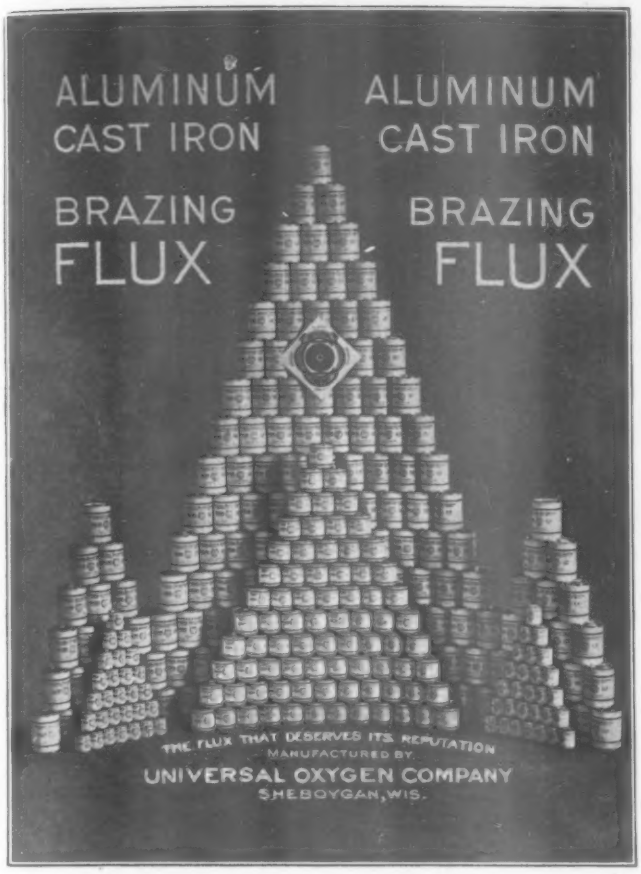

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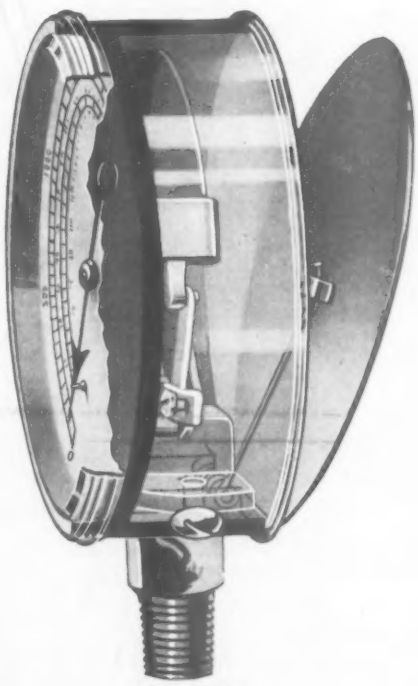

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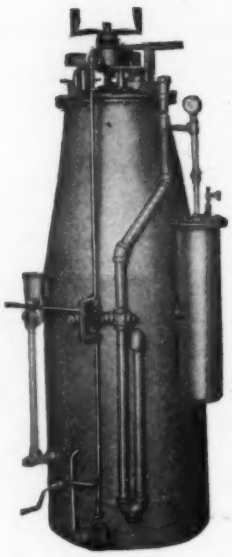

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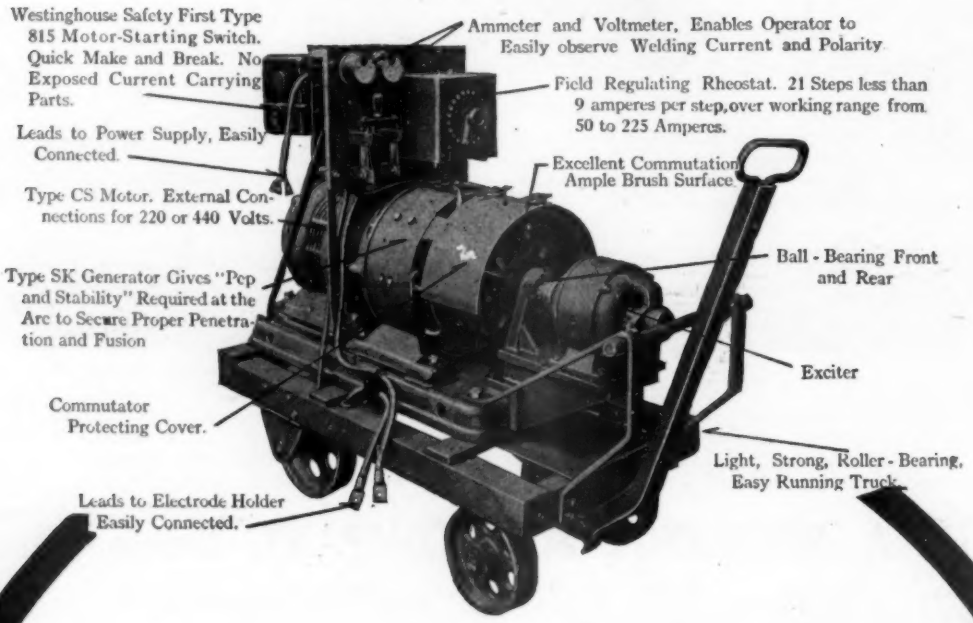
An Efficient, Effective Arc Welder That Will Increase the Scope of Arc Welding in Any Shop—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That I will investigate the practicability of using hydrogen in cutting operations.

That I will follow the slogan,

"Better welding and more of it."

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Make The Test This Buyer Did

The following is a facsimile of the report of W. E. Irish, Plant Engineer, to G. C. Brainard, General Manager of The Hydraulic Pressed Steel Company, relative to a test made in their plant. Portions of the report which would reveal the names of other welding equipment have been cut out.

INTER-DEPARTMENT COMMUNICATION

The HYDRAULIC PRESSED STEEL CO.

CLEVELAND, O.

ATTENTION OF Mr. G. C. Brainard, GENERAL MANAGER. DATE March 20th, 1920

SUBJECT: Arc Welding.
REFERENCE: Telephone request for figures on performance.

On comparative test run in this plant on three makes of welding machines, on Feb. 10th, 1920, the following results were obtained:

Make	Diameter Wire	Time to weld 2 ft.
Lincoln	3/16	6 mins. - 10 sec.
Welder "B"	3/16	8 mins. - 20 sec.
Welder "C"	5/32	13 mins. - 0 sec.

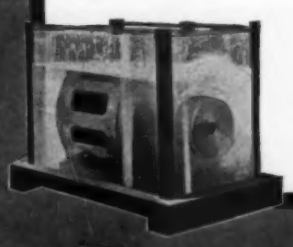
The test was started using 3/16 wire on all machines, but was changed to 5/32 on the Welder "C" as it was impossible to hold a steady arc with the heavier wire and get a good weld. This of course slowed up the Welder "C" set as there were more changes of wire to make.

The Lincoln Arc Welder will do at least 20% more welding work per day under actual commercial welding conditions than any other electric welding equipment made.

This is a well considered statement based on results of many competitive tests, and The Lincoln Electric Co. are prepared to prove the claim at any time or place where welding is being done by commercial operators.

"Link Up with Lincoln"

This Standard Lincoln Motor operated over 3 years under water without damage.



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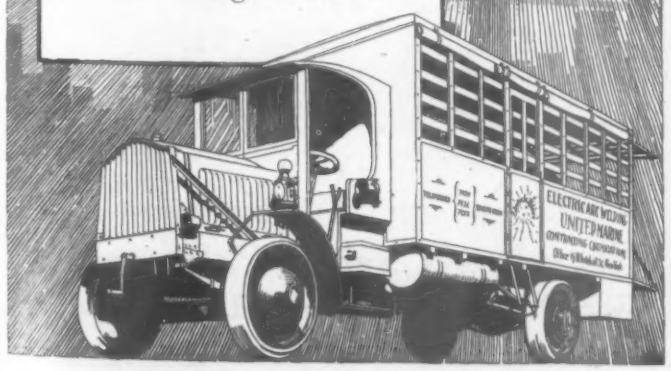

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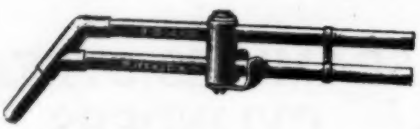

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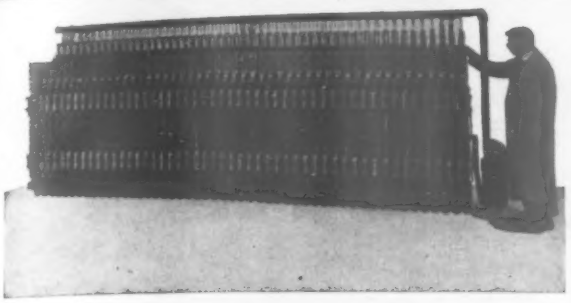

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FOR WELDERS

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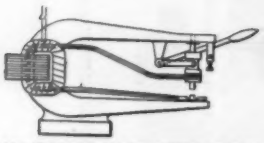
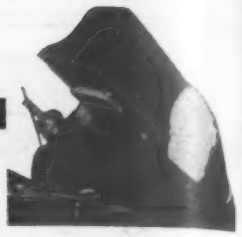


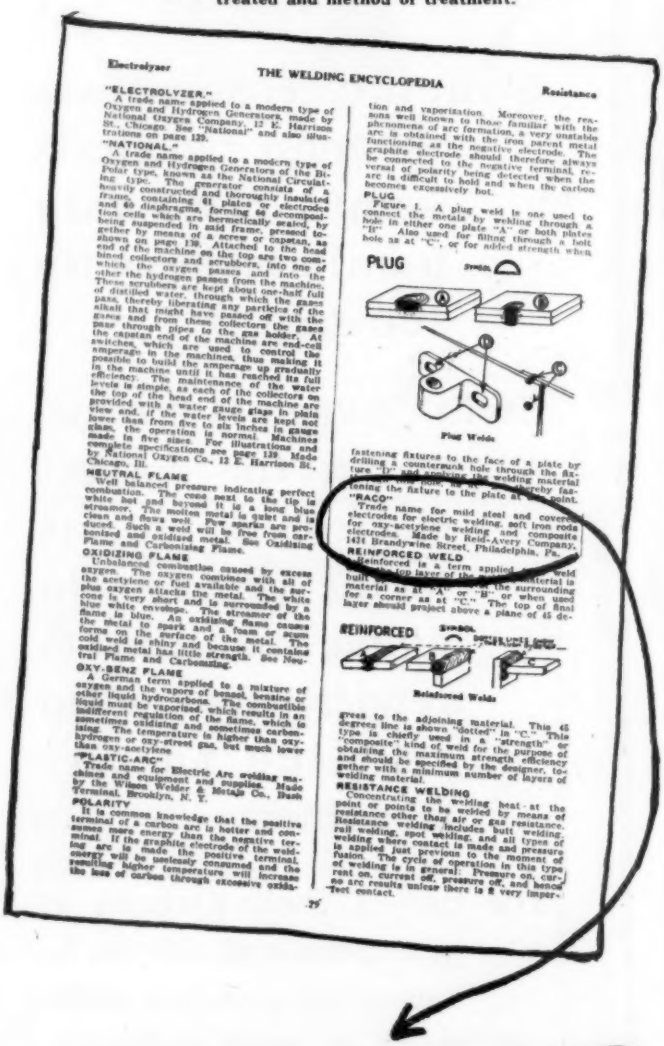
FOR THE RESISTANCE WELDER



FOR THE ELECTRIC ARC WELDER

If You Weld— Get The Welding Encyclopedia

This is a composite page (1/3 actual size) made up to show the style of type and type-page, variety of subjects treated and method of treatment.



Electrolyzer THE WELDING ENCYCLOPEDIA Resistance

"ELECTROLYZER."
A trade name applied to a modern type of Oxygen and Hydrogen Generators, made by National Oxygen Company, 12 E. Harrison St., Chicago. See "National" and also illustrations on page 139.

"NATIONAL."
A trade name applied to a modern type of Oxygen and Hydrogen Generators of the Bi-Polar type, known as the National Circulating type. The generator consists of a heavily constructed and thoroughly insulated frame, containing 61 plates or electrodes and 60 diaphragms, forming 60 decomposition cells which are hermetically sealed, by being suspended in said frame, pressed together by means of a screw or capstan, as shown on page 138. Attached to the head end of the machine on the top are two combined collectors and scrubbers, into one of which the oxygen passes and into the other the hydrogen passes from the machine. These scrubbers are kept about one-half full of distilled water, through which the gases pass, thereby liberating any particles of the alkali that might have passed off with the gases and from these collectors the gases pass through pipes to the gas holder. At the capstan end of the machine are end-cell switches, which are used to control the amperage in the machines, thus making it possible to build the amperage up gradually in the machine until it has reached its full efficiency. The maintenance of the water levels is simple, as each of the collectors on the top of the head end of the machine are provided with a water gauge glass in plain view and, if the water levels are kept not lower than from five to six inches in gauge glass, the operation is normal. Machines made in five sizes. For illustrations and complete specifications see page 139. Made by National Oxygen Co., 12 E. Harrison St., Chicago, Ill.

NEUTRAL FLAME
Well balanced pressure indicating perfect combustion. The cone next to the tip is white hot and beyond it is a long blue streamer. The molten metal is quiet and is clean and flows well. Flow sparks are produced. Such a weld will be free from carbonized and oxidized metal. See Oxidizing Flame and Carbonizing Flame.

OXIDIZING FLAME
Unbalanced combustion caused by excess oxygen. The oxygen combines with all of the acetylene or fuel available and the surplus oxygen attacks the metal. The white cone is very short and is surrounded by a blue white envelope. The streamer of the flame is blue. An oxidizing flame causes the metal to spark and a foam or scum forms on the surface of the metal. The cold weld is shiny and because it contains oxidized metal has little strength. See Neutral Flame and Carbonizing.

OXY-BENZ FLAME
A German term applied to a mixture of oxygen and the vapors of benzol, benzine or other liquid hydrocarbons. The combustible liquid must be vaporized, which results in an indifferent regulation of the flame, which is sometimes oxidizing and sometimes carbonizing. The temperature is higher than oxy-hydrogen or oxy-street gas, but much lower than oxy-acetylene.

"PLASTIC-ARC"
Trade name for Electric Arc welding machines and equipment and supplies. Made by the Wilson Welder & Metals Co., Bush Terminal, Brooklyn, N. Y.

POLARITY
It is common knowledge that the positive terminal of a carbon arc is hotter and consumes more energy than the negative terminal. If the graphite electrode of the welding arc is made the positive terminal, energy will be uneconomically consumed and the resulting higher temperatures will increase the loss of carbon through excessive oxidation and vaporization. Moreover, the reasons well known to those familiar with the phenomena of arc formation, a very unstable arc is obtained with the iron parent metal functioning as the negative electrode. The graphite electrode should therefore always be connected to the negative terminal, reversal of polarity being detected when the arc is difficult to hold and when the carbon becomes excessively hot.

PLUG
Figure 1. A plug weld is one used to connect the metals by welding through a hole in either one plate "A" or both plates "A" and "B". Also used for filling through a hole as at "C", or for added strength when

PLUG

Plug Welds

fastening fixtures to the face of a plate by drilling a countersunk hole through the fixture "B" and welding into the hole, thereby fastening the fixture to the plate at that point.

"RACO"
Trade name for mild steel and covered electrodes for electric welding, soft iron rods for oxy-acetylene welding and composite electrodes. Made by Reid-Avery Company, 1434 Brandywine Street, Philadelphia, Pa.

REINFORCED WELD
Reinforced is a term applied to a weld built up on top layer of the material is as at "A" or "B", the surrounding material as at "A" or "B", or when used for a corner as at "C". The top of final layer should project above a plane of 45 degrees to the adjoining material. This 45 degree line is shown "dotted" in "C." This type is chiefly used in a "strength" or "composite" kind of weld for the purpose of obtaining the maximum strength efficiency and should be specified by the designer, together with a minimum number of layers of welding material.

REINFORCED

Reinforced Welds

RESISTANCE WELDING
Concentrating the welding heat at the point or points to be welded by means of resistance other than arc or gas resistance. Resistance welding includes butt welding, rail welding, spot welding, and all types of welding where contact is made and pressure is applied just previous to the moment of fusion. The cycle of operation in this type of welding is in general: Pressure on, current on, current off, pressure off, and hence no arc results unless there is a very imperfect contact.

"RACO"
Trade name for mild steel and covered electrodes for electric welding, soft iron rods for oxy-acetylene welding and composite electrodes. Made by Reid-Avery Company, 1434 Brandywine Street, Philadelphia, Pa.

WHAT is a "Raco" electrode? Who makes it? Where is it made? The welder who hears someone mention this electrode will ask these three questions. And the Welding Encyclopedia will answer them.

THIS book covers every phase of the art of Autogenous Welding as no other publication or group of publications has ever covered it. The Dictionary section of the text alone contains more information of value to welders than any book we know of. All the words and terms used in welding are carefully defined and illustrated. This section includes the explanation of all trade names that have been given to things the welder uses, arranged alphabetically for easy reference, and supplying the makers' names and addresses. All this information is impartial, the idea is to present information that will enable the welder to understand his work better, no matter what the process is.

IN the Instruction section will be found the approved methods of welding all standard metals by the various processes, such as Oxy-Acetylene, Electric Arc and Thermit. A carefully prepared group of tables and charts give the welder here a big store of useful "dope," right at his finger-tips all the time.

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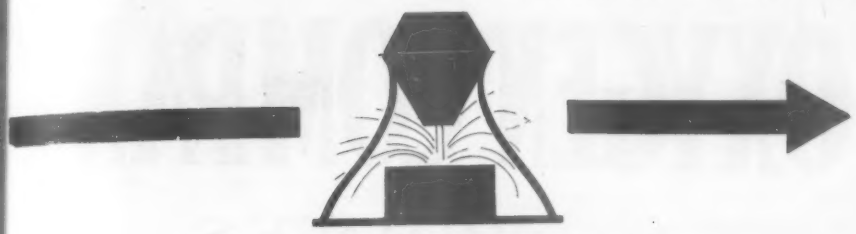

FOR THE THERMIT WELDER

The Welding Encyclopedia

Is a Complete Reference Work

FOR ALL WELDERS

No matter what welding process you are using, you will find the theory of it explained in this book, and instructions for it that are in accordance with the most up-to-date practice. All the standard metals are discussed here, and the different ways of welding them. The installation of equipment, the care of it, and the things to avoid in welding, are all subjects that every welder should read. He should know how to test his welds, so he can check up on his work from time to time, just as he should know something of the other welding processes, their possibilities and their limitations. And materials are as important as methods, a reliable Buyer's Index enables the shop-owner to make purchases of equipment with confidence. These are just a few suggestions of the helpfulness and usefulness of THE WELDING ENCYCLOPEDIA to the welder, the welding foreman, the superintendent, the shop owner, the foundry manager and the engineer. The book is a thorough and practical treatise on all forms of welding, profusely illustrated, and arranged so that any required bit of information can be found easily and quickly. Have you ordered your copy?

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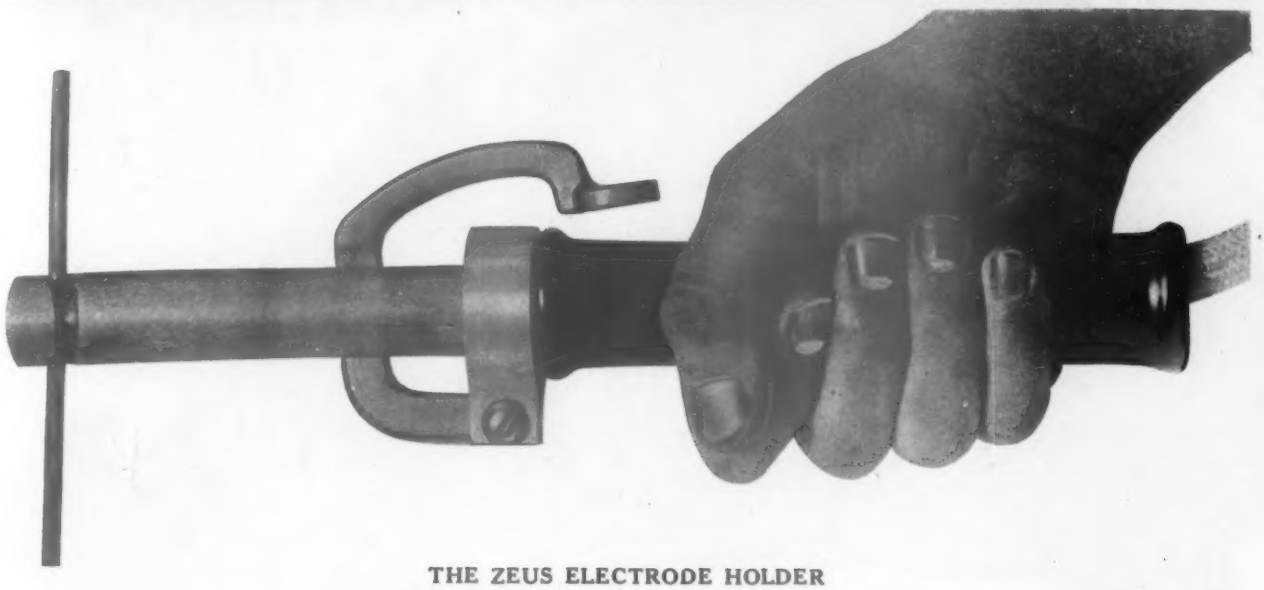

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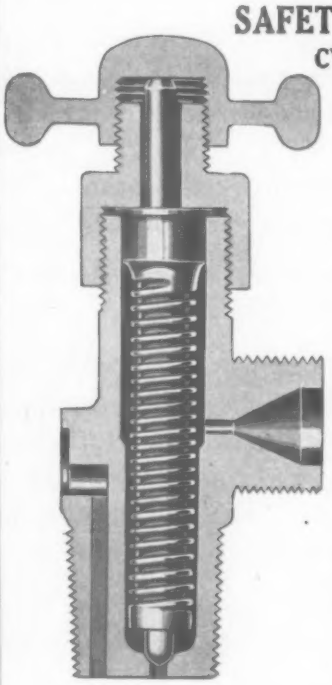

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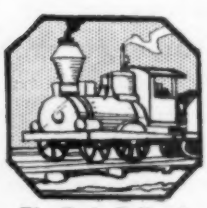

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THE WELDING ARC

By A. W. Slocum*

DURING the summer of 1918, the writer was associated with the Welding Research Council. During that period, he made a careful study of the trade the Welding Arc.

Transmission of the metal in the form of vapor appeared to be the most probable hypothesis. This part of the phenomena, however, is so marked by the unavoidable spraying and spluttering of the electrode and plate that many have considered this as the essential part of the phenomena. This point of view is ably presented by Professor R. G. Hudson of the Massachusetts Institute of Technology in his article on a theory of metallic arc welding published in the first issue of the Journal of the American Welding Society.

Professor Hudson says: "It would appear from the observed facts that the metal deposited during metallic arc welding is transmitted in part at least in the form of minute particles which are projected from the electrode globule by the internal expansion of some vapor, possibly carbon monoxide."

He also says: "Under the circumstances, it may be seen that the melting of the iron is delayed by the heat absorbed by the other constitutents of the electrode, and that this fact together with the limited time of application of high temperature disproves the possibility that the iron is completely vaporized in the welding process."

Stated in such terms, Professor Hudson's conclusions are entirely correct. The metal is transmitted *in part* from the electrode to the plate and from the plate in all directions in the form of spray or globules. And if it is transmitted in part as spray, it is evident that it cannot be *wholly* transmitted as vapor. The question whether the chief element in the phenomenon is vaporization or gaseous propulsion is, however, still a live one. The writer has little doubt that transfer in the form of vapor will ultimately be accepted as the most probable hypothesis.

It is not a wholly new hypothesis. Frequent reference to a kind of vapor formation is made in the literature of the common arc. Such references are generally made in a suggestive rather than positive manner, but the phenomenon of the common arc is more complicated than that of the welding arc. In the common arc the vapor is not produced so rapidly as to sweep the air entirely out of the space between the electrodes. In this case the vapor which is formed from one of the electrodes largely returns and condenses on the electrode from which it comes. This phenomenon can be clearly seen with a microscope of about twenty magnifying power used to view the behavior of a small current arc. Small condensed globules of microscopic size can be seen to emerge from the core of the arc and fly in curved paths towards the respective electrodes from which they come. Some of these particles escape into the air borne along by the air currents. Some return to the electrode at a distance from the spot on which the arc is playing and there deposit as a yellow dust. Some return to the electrode close to the spot from which the arc plays and form a beautiful orange colored coral like growth. The orange deposit is magnetic, the yellow powder is not magnetic. These growths and powder deposits for arcs with different metals are described by Professor Duffield, Phil. Mag., 1918.

When the current strength becomes sufficiently large to sweep the air entirely away and form a vapor core from electrode to electrode we have the "hissing" or welding arc.

It is true that the hissing arc is generally referred to as the action of oxygen getting at the crater largely on the basis of the careful experiments of Mrs. Herta Ayrton.

She showed beyond doubt that under certain conditions the addition of oxygen would cause a silent arc to become a hissing arc. She also found that a stream of hydrogen sent into an arc which was surrounded by atmospheric oxygen would cause the arc to become a hissing arc, while hydrogen sent into an arc which was surrounded by nitrogen would not cause the arc to hiss. She naturally associated hissing with the presence of oxygen, but it is clear that it might just as well be associated with the increased heating effect and the more rapid formation of vapor to form the vapor core from electrode to electrode. It might be a suitable problem for a student learning the methods of research work to repeat Mrs. Ayrton's experiments and settle this point, but it does not seem doubtful to the writer what his final result would be.

That the conditions in the arc are favorable to vapor formation is clearly shown by the results of the measurements of the electrode tips by Hagenbach and Langbein. The following paragraph is quoted from Science Abstracts (Section A, Physics), April 1919:—

"*Temperature of the Electrodes in the Arc.* A. Hagenbach and K. Langbein (Archives des Sciences 1. (Sec. 5) pp. 48-54, Jan.-Feb., 1919). For current densities not too small the anodes of metallic arcs (Silver, Copper, Iron, Nickel and Tungsten) are heated at the tip by the current up to the temperature of ebullition, while the cathodes are heated less. If the end of the electrode is strongly oxidized and forms an oxide with a high temperature of ebullition, (Aluminum, Zinc and Magnesium) the temperature rises still higher, probably up to the temperature of ebullition of the metallic oxide. If oxidation is prevented by using an atmosphere by nitrogen, the temperature is lowered to the ebullition temperature of the metal. The temper-

*Professor of Physics, University of Vermont.

ature of the cathode is found to be the same as that of the anode in the case where metallic oxides are formed."

In the electric arc the heat that raises the temperature of the electrode tips is produced and delivered directly in the surface of the tips. The heat is produced in accordance with the law; watts equal the product of amperes (current strength) and volts (electrode fall). To liken the process to the heating of the surface of a bullet by the heat produced in the burning powder is to totally disregard the peculiarity of electrical activity.

The secret of the electrical activity of the arc lies in the electrode fall. To attempt to describe its action is a matter of extreme delicacy and great difficulty.

It is directly associated with the electric force necessary to produce thermions from the tips in sufficient quantity for the current strength. This electric force is conditioned by the temperature of the electrode tips, is affected by the presence of oxides, depends upon the material in the surface layer of the tip, is of different magnitude at the anode from that at the cathode and the force at one electrode is affected by the freedom of thermionic liberation at the other electrode. It is the intricate interrelationship of these factors that makes the arc a difficult phenomenon to examine experimentally, and also the reason why we find so much misguiding information in the assumed results of experiments. The one factor which has probably needed the closest attention; namely, the actual state of temperature of the surface layers of the tips, has seldom received consideration. Before the days of the tungsten filament, the nitrogen filled lamps and the thermionic amplifiers and rectifiers, the importance of the temperature, was not sufficiently appreciated.

For the purpose of considering the electric activity of the arc, let us take a low current arc between two welding wire electrodes ⅛ inch in diameter, and then increasing the current by steps, consider the changes that occur with each step.

When the arc is first struck, the electrode tips are cold, the electrode fall is very large, heat is added to the surface of the tip at a rate proportional to the product of the current strength and the electrode fall, the temperature of the tip rises very rapidly, and the electrode fall diminishes with corresponding rapidity. As the temperature rises, the conduction and radiation of heat away from the surface of the tip increases. There comes a time when the heat produced in the surface just balances the heat conducted and radiated away.

However small the current, so long as it is large enough to maintain an arc, this stage of equilibrium is not reached till the temperature has risen considerably above the melting point of the electrode, and examination with a microscope shows that the surface is vaporizing with considerable rapidity though the greater part of the vapor returns as condensed fine globules to the electrode from which it comes. When the equilibrium between the heat produced and the heat conducted and radiated away has become established, the arc burns steadily so long as the temperature of the surface of the tips, the material in the surface of the tips, and the current strength remains unchanged. A voltmeter joined to the electrodes maintains a constant reading.

If, now, we increase the current, we increase the rate of heat supply. This increases the temperature of the tips and this in turn reduces the electrode fall. Soon the equilibrium stage is reached with the electrodes at a higher temperature than in the first case, lower electrode falls and a smaller reading of the voltmeter across the arc.

When we increase the current to about 8 or 9 amperes, the surface of the anode reaches the boiling point, the electrodes splutter and molten drops fall from the tips. Thus it takes 8 or 9 amperes for a ⅛ inch electrode to supply the heat conducted and radiated away when the temperature of the tip is at the boiling point.

With a current in excess of about 10 amperes, an arc between two welding wire electrodes of ⅛ inch diameter blows up with excessive spluttering. With a ⅛ inch welding wire as one electrode and a plate to be welded for the other electrode, the arc burns without too excessive spluttering with 150 or even 175 amperes flowing.

This leads us to an interesting question which pertains to the welding arc alone. What influence on the welding wire can the plate have to increase the current capacity of the wire from 10 to 150 amperes? Alternating current behaves in this respect as direct current. The phenomenon is then one that depends upon the square or some even power of the current. This consideration limits the phenomenon to one of heat effect. We have, therefore, only two hypotheses to consider, the heat effect in the propulsive expansion or formation of gases, and the heat effect in the production of vapor of the material of the surface of the tip.

For the propulsive expansion or chemical formation of propulsive gases in the interior of the electrode, the heat must be conducted inward from the surface to the interior of the electrode. It is difficult to see how the presence of the plate as opposing electrode can affect this rate of conduction inward so as to reduce it to 1/15 of its value when another wire instead of the plate is the opposing electrode. On the hypothesis of the boiling from the surface of the electrode, it is easy to see that the presence of the plate will produce precisely such a result. Not only this, but it is also easy to see how too strong a current produces a cutting arc rather than a welding arc.

When the vapor formation becomes sufficiently rapid to maintain a tube of vapor from electrode to electrode from which the air is completely expelled, then the arc is behaving precisely like a steam heating plant. The boiling of the surface of the electrode into vapor absorbs latent heat. The condensation of the vapor on the welding plate sets free the latent heat to be conducted away by the plate. The vapor condensing on the plate raises its temperature to the boiling point and we then have the plate in condition for its maximum rate of heat conductance and the voltage drop across the arc at its lowest possible value. Further increase of current strength has no effect upon the voltmeter reading across the arc so long as the material of the surface layers of the tip and plate remain unchanged, but it does begin to boil away the surface of the plate, boiling faster and faster as the current gets stronger and stronger and, in some cases, forming a blast of vapor strong enough to cause a deposit of material at a distance of one or two inches from the spot on which the arc is playing and at the same time cutting a hole in the plate immediately under the arc.

On the vapor hypothesis, so long as the current strength is suitable for welding, the amount of metal deposited is proportional to the excess of current above that necessary to keep the temperature of the electrode tip at its boiling point.

On the vapor hypothesis, the maximum current that can be advantageously used in a given case is limited by the heat conductance of the welding plate.

On the vapor hypothesis, the rule is suggested of choosing a current strength suited to the maximum heat conductance of the plate, and use the smallest wire electrode that will handle the current.

In the writer's limited experience with welding during the summer of 1918, these rules seemed to be justified, though often other factors such as an unusual amount of spluttering of the electrode appeared to mask them.

The vapor hypothesis or the gaseous propulsive hypothesis alone cannot furnish a satisfactory theory of the arc behavior. For this purpose, we need a study of the electrode falls and such a study takes us beyond the field of welding.

It is, however, very important for welders to note some of the peculiarities of the arc behavior and the electrode falls.

The arc consists of two streams flowing in opposite directions. Increase the intensity of one of the streams and for a given

current strength, the other stream diminishes in intensity. Interrupt either stream and the arc goes out.

In very low current arcs, 1/10 ampere or less, the temperature of the tips are relatively low, and the cathode fall is higher than the anode fall, and the cathode surface becomes hotter than the anode surface. In the case of currents above about one ampere, this is reversed and the temperature of the anode becomes hotter than that of the cathode.

It is easier to start an arc from a cold spot on an anode than from a cold spot on the cathode. The arc is stable with one cathode and two anodes, but it is unstable with one anode and two cathodes. These are the reasons why the wire should be made the cathode in welding. The arc creeps along the cool plate better when it is made the anode.

In conclusion, it seems apparent that the vapor hypothesis of metal transfer deserves the careful consideration of experimenters with the welding arc, that the formation of propulsive gases or vapors of constituents of lower boiling points deserves careful study for their proper control, and that the interpretation of experimental results needs a careful application of the principles of heat, electricity and chemistry. Until we are able to apply these principles simultaneously and harmoniously, we cannot have a satisfactory theory of the arc.

CANADIAN WELDING SOCIETY FORMED

At a meeting held in the Prest-O-Lite Company offices, Toronto, December 16th, at which were what may be styled the foremost exponents of the welding industry of Canada, it was decided unanimously to form an organization to be known as THE CANADIAN WELDING SOCIETY.

The Society will embrace all processes of welding, including gas, electric and thermit, and all classes of men and companies connected with or interested in the art. Special attention will be given to the spreading of publicity regarding the trade both to the general public and to the welders themselves.

The Society will endeavor to assist in the general advancement of the trade, to work for co-operation amongst companies, between employers and employees, for co-operation with other technical bodies for the advancement not only of the welding trade, but of all other industries in the metal-working lines.

That a need for some such organization has been felt was plainly indicated by those present at the meeting, and by the complete unanimity of thought and action.

Joseph N. Robinson, Managing Editor of "The Canadian Welding Journal," was appointed chairman, and A. A. Stewart, secretary. These two officers together with Mr. F. Borys, commercial manager of L'Air Liquide Society form an executive committee to carry on until the election of permanent officers and the first general meeting which will be held early in January.

INTERESTING ENGLISH COMMENT ON WELDING

Recent favorable comment on welding by the "Engineer," England's ultar-conservative engineering journal, is of special interest to American manufacturers at this time, when there is so marked a tendency in this country to adopt this process of jointing structures. The oxy-acetylene industry is much older in Great Britain than here, and it is reassuring to observe that welding applications in England coincide with advanced American practice.

"There can be no doubt about the attractiveness of welding as a means of making joints in most metal structures," says the "Engineer." Its advantages are so obvious and appear to be so great. First and foremost is the advantage of cheapness and convenience. Welding can be carried out not only with much less labor, but with much greater speed and convenience than by the old method of making joints. By comparison, riveting, involving as it does, the drilling or punching of holes in accurately determined positions, followed by the insertion of the rivets themselves, is a clumsy and costly operation. From the point of view of the strength of the resulting joint, also, riveting is far from satisfactory. Only by great care in design and construction can a strength approaching as much as 70 per cent of the original bar be obtained, and in most joints the strength is very much less. Further, there are many cases where broken parts can be rejoined by welding, while riveting is out of the question and other methods are impracticable. It is small wonder, then, that this method of jointing structures by autogenous fusion is finding ever wider and wider application."

"Industrial Gases," another authoritative English publication, observes:

"In welding, more than in most trades, aptitude and experience are required to produce the expert welder. . . The expert welder must be trained to deal with all sorts and conditions of metal and their welding fluxes. He should be a fair metallurgist and chemist, with some knowledge of the strength of material and the strains liable to be set up in structures through the welding repairs he has to carry out. Above all, he must know how to weld without creating internal strains, or the best way to disperse such strains after the weld has been effected."

American welding engineers will not entirely agree with the English editor in his belief that the expert welder "should be a fair metallurgist and chemist." However desirable a technical knowledge of metallurgy and chemistry of a "fair" order may be in a surpervisor of welding, it does not in practice exist as the size qua non of the expert operator, who may do very well with a general conception of expansion and contraction and methods of preheating, torch manipulation and after cooling or annealing. Expert welders employ various ways of handling the torch, generally adopting styles the operators individually prefer. It is not essential that supervisors of welding be themselves expert in manipulation of the torch in order to competently pass on the quality of welds. In fact, wherever there exists a tendency to impose individual ideas as to particular modes of torch manipulation the results may often prove disappointing. Supervision of welding is very important, and is a necessary step to secure better work, but the requisite qualifications of supervisors and welders should not be confused. The supervisor is the officer who directs and inspects; the operator the subordinate who executes. The wise officer will always respect the competent workman's individual slants so long as he produces good welds and will not hamper him with needless interference or demand of him engineering knowledge that would render his own technical education superfluous.

The editor of "Industrial Gases" sees the greatest good to the welding industry in the large number of welding schools that are now teaching the process in England and America, and urges welders to take advantage of instruction courses.

No one can doubt the importance of the welding school as a factor in producing the competent welder, and in this connection it is worthy of observation that manufacturers of equipment in this country were among the first to realize the need for technical as well as manual instruction, as is evidenced by the welding schools conducted by the leading manufacturers of welding apparatus. Some of these have gone a step further in maintaining for the benefit of customers engineering departments that deal with the problems of individual users, in many instances going to expense far in excess of any immediate return that could be expected.

With these engineering resources at their command, American welders and manufacturers may well feel that they are treading on safe ground in determining where and how oxy-acetylene may be advantageously employed.

CHICAGO SECTION ANNOUNCES 1921 PROGRAM

The American Welding Society, Chicago Section, announces that during 1921 the regular meetings will be held on the fourth Friday of each month. The dates for the first six months of the year will be: Jan. 28, Feb. 25, March 25, April 22, May 27, June 24.

WHY SOME WELDS FAIL

By T. D. Sedwick*

IN considering the various reports and articles covering the subject of welds and welding, it appears that these reports deal largely, or almost entirely, with details of the methods or means of making the welds, the character of the material to be used in building up the weld, the plan of building up the section, and the properties of the material after it has been placed in the weld. Large stress is laid on the necessity of using the material and method that will produce a good bond between the added material and the original metal, also that the added material should show good physical properties in regard to the soundness, ductility and strength, special endeavor being made to have these last-mentioned properties approach as closely as possible that shown by the original metal.

In case of poor results shown either by laboratory tests or actual service, the inclination is to attribute such results to the material used; the method of making the weld, a poor operator, or the contributing effect of all three of these factors. However, there are other points that enter into the final results, and two of the important ones are as follows:

1. Was the metal in the casting, forging, etc., in such a physical condition that it was fit to be welded and afterwards give good service; for instance, did the metal originally fail on account of the presence of segregation of the various chemical elements; did it contain blowholes, porosity, or were there thermal stresses left from the original forging or the casting; or had the previous service fatigued the metal to the extent that it was inherently weak, this being brought about by service beyond its elastic limit or being subjected to prolonged vibratory stresses?

2. Was the original metal adjacent to the weld deleteriously affected by the welding operation?

Some take the factors mentioned in the first instance into consideration in addition to others, but I do not believe that very many, particularly the shopmen, give much thought to any action which may take place on the original metal. Tests and observations made on failed material and special tests specimens have shown that although good conditions prevailed in regard to all the points raised, the welds failed.

Investigation on various welds has shown that in the majority of the cases, especially in certain classes of material, the welding heat or the process of preheating has affected the metal in the sections being welded, this effect being in the nature of a transformation of the physical structure of the steel, and in case of localized high temperatures, the main body of the material absorbing the heat so fast that there resulted a quenching action on the heated metal. In the majority of the instances the extreme hardening action will be localized near the surface, immediately adjacent to the added metal. In some cases of preheating, it has been shown that the high temperature causes a change in the physical structure of the metal, and while it is not usually so localized as in the case of the action of the welding heat alone, at the same time certain thermal stresses are set up, these stresses being in addition to those created by the heat generated by the welding process. These conditions have been found in material of thick sections where the heat would not be readily absorbed throughout the section, and where the chemical content, especially the carbon, was such that it rendered the metal readily susceptible to structural changes, resulting in a hardened condition.

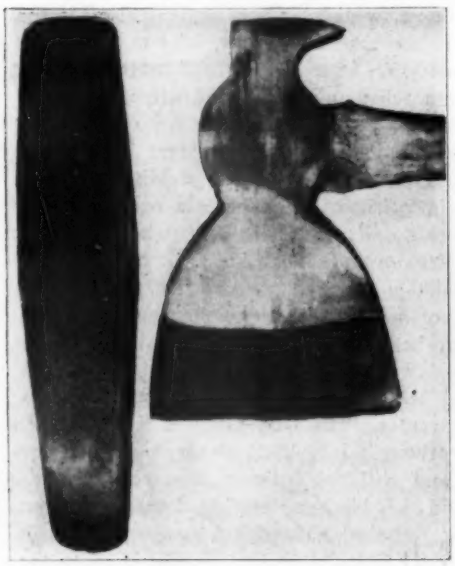

Fig. 1. How Etching Brings Out Hardened Areas.

Fig. 2. Failed Piston Rod.

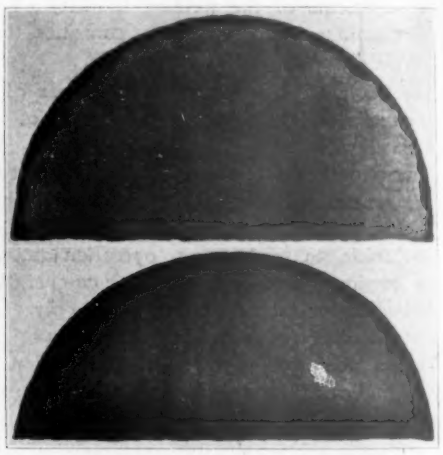

Fig. 3. Annealing Has Removed Hardened Area.

To illustrate some cases along this line, photographs have been secured showing several special tests and also some views of failed material.

In regard to the tests mentioned: A great many of these were made to develop illustrations for the parties concerned, particularly the practical shopmen, that proper annealing in the majority of the cases should be done after the weld has been completed and that a thorough annealing would improve the physical condition of the metal, thereby causing it to render better service, this thorough annealing to be made by placing the metal in a furnace and annealing it in the proper way by giving it soaking heat and then cooling so that the whole mass could adjust itself to a uniform condition throughout. The idea of causing a self or automatic annealing to take place by preheating, as I look at it, is going at the proposition backwards

†*Paper read before the American Welding Society, Chicago Section, December* 22, 1920.

Engineer of Tests, Rock Island Lines.

and trusting to luck that we have not done more damage than good. I appreciate that, in order to relieve the shrinkage strains which might be set up in certain sections, it is necessary at times to preheat to take care of these shrinkages during the cooling after welding. What I am advocating is that after this has been done, we follow out a thorough annealing program. In this way any strain or hardened condition that has been set up by preheating, or by the welding heat, will be eliminated and if such precautions have been taken, we would then have a product whose service would depend mainly on the quality of the material in the weld, and the perfection of the weld as a weld.

In preheating with a torch of any kind, there are certain zones in this torch flame that are of a higher temperature than others, and in view of the fact that it too often happens that a sufficient length of time is not taken in preheating to permit a soaking heat to be given to the steel, more or less localized heated areas are produced and, as stated before, these in turn will do injury by multiplying the thermal stresses which were not eliminated during the subsequent period of cooling.

In regard to the subject of annealing in general: It seems to me that too little attention is given to this point, even in cases where no welding is done. In reclamation plants where old material is re-worked, for instance, a worn out or failed forging will be re-forged, either into a forging of a smaller size of the same class or may be forged into other classes of forgings. When originally forged there may have been set up thermal stresses in this material, and these were not removed, or the material may have been overheated or even burnt. Later, during its actual service, fatigue stresses and unsatisfactory physical structure may have been produced. On forging again, unless done under best conditions, further stresses will be set up and then, without annealing to refine the grain and remove these stresses, the forging will be returned to service again. While it may give some service, if we had gone a little further and treated it properly, the extended service, in my opinion, would have been sufficiently great to more than recompense for any extra trouble or expense involved in a final annealing after forging. This same thought applies to welding of failed material or broken material which, through its previous service, has been subjected to severe tensile strain or vibratory stresses. Later, the welder will do his work on the material and return it to service without attempting to anneal. It appears that there are a great many misconceptions in regard to the process of annealing and a great many shopmen fail to observe the rule that it requires time for a piece of steel to adjust itself to the annealing temperature and be heated throughout to the same temperature. For instance, I know on one particular forging the party was instructed to thoroughly anneal the forging, and

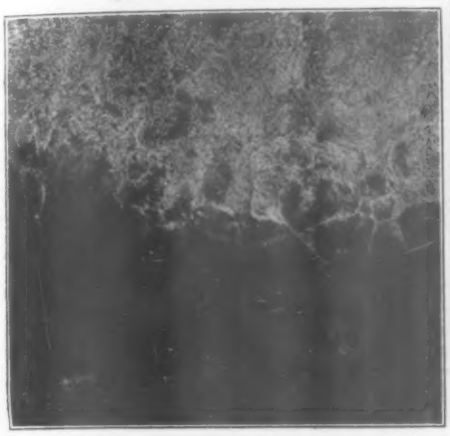

Fig. 4a. Heated Area Before Annealing.

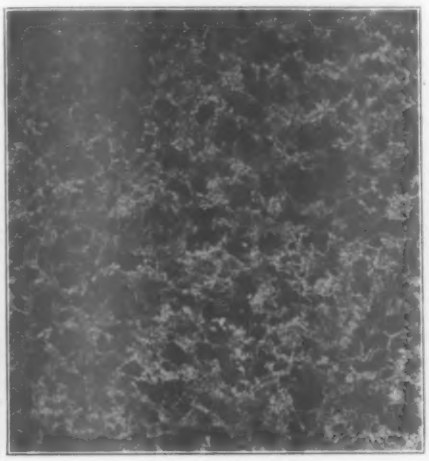

Fig. 4b. Normal Structure.

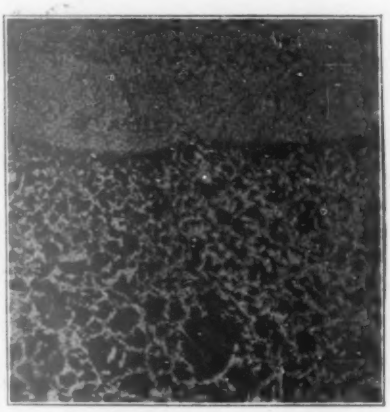

Fig. 5a. Annealed 3 hrs. at 1500° F. Cooled in Furnace. Mag. 100D.

Fig. 5B. Annealed 3 hrs. at 1500° F. Cooled in Air. Mag. 100D.

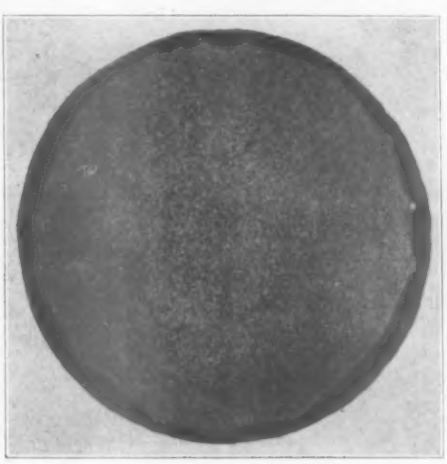

Fig. 6. Condition of Metal When Rod Broke.

Fig. 7. Note Irregular Application of Metal. The etching has brought out here a marked difference between the skill of the operator as compared with the workmanship in the built-up rod shown in Fig. 2. The author suggests that etching might be used to test the welder's skill with the torch or electrode. Figs. 6 and 7 certainly look amateurish compared to Fig. 2.

In the majority of the shops, especially the larger shops where special annealing furnaces have not been installed, there are always some furnaces of sufficient size in which at least the smaller castings and forgings could be annealed and this annealing could be done at a comparatively low cost; for instance, at the close of the day, as space is being left unoccupied by the regular work of the shops, the welded material could be placed in the furnace and without any material increase in the cost of fuel be annealed over night. This plan would not check production of the regular work.

he advised that he was following this out. However, later it was found that he was simply sticking the forging into a blacksmith fire so that the welded area was buried in the fire. While the immediate area around the weld could be annealed in this way, at the same time, it is my opinion that it is a half-hearted way of going about the matter. One of the illustrations which we have on reclaiming of an axle will bring out the fact that

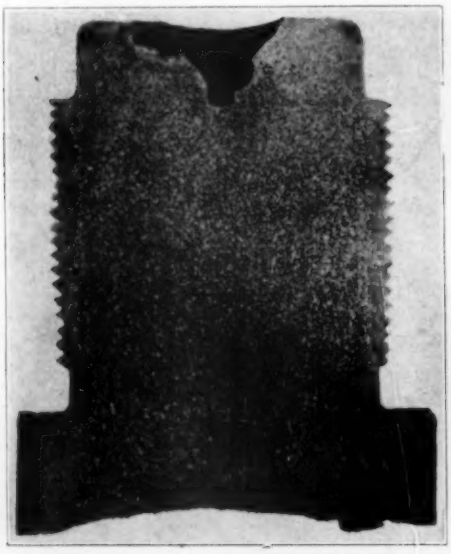

Fig. 8. Cross Head Fit Built up by Electric Arc.

Fig. 9. Result of Neglecting Heat Treatment.

Fig. 10. The Same Piece After Annealing.

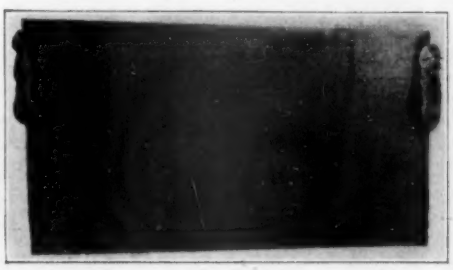

Fig. 11. Metal Added After Preheating.

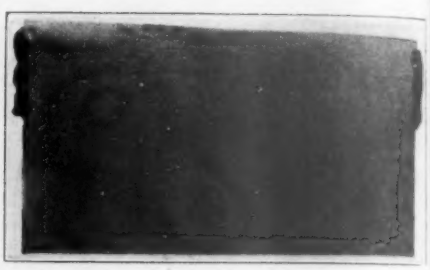

Fig. 12. After Annealing Piece in Preceding Photograph.

under such conditions, while the extreme highly localized affected areas will be removed, at the same time more or less minor stresses will be set up back along the forging and to do the job right the forging as a whole should have been subjected to the annealing heat.

I feel that you will agree with me that such methods are hardly treating the proposition fair, especially to expect to get 100 per cent service, as compared with new material, out of material to which we have added or in which we have produced unsatisfactory conditions rather than reduced them. I do not want you to infer that I am looking at this matter from a strictly theoretical standpoint but, in view of the tests and the various failed material which have come to our attention, these remarks are justified. The methods mentioned are not limited to any one shop, but prevail more or less in general. In fact, it has often occurred to me that the only reason, in a great many cases, that even where a new or original forging may give good service, it is due to the fact that the designer has allowed for such a great factor of safety or fiber stress that the shopmen in working up the material can do almost anything with it, and we will still have some service left. This applies to the forging as well as the welding. Assuming that a designer had originally made provisions for a factor of 10 and later the section was broken and welded, this weld would have in reality a factor of 5, due to strains, etc., set up. The designer attempts to take into consideration not only the ordinary service requirements but to a certain extent, abnormal requirements that the material might need in the case of emergency, such as shocks or extreme tensile or bending stresses. If we have reduced this factor 50 per cent, the material might be able to go along in ordinary service with safety. However, for the emergency cases we may have eliminated the safety margin entirely. Sometime during the life of the material, it is going to run into extreme, unsual conditions. Then, if we have not taken the proper precautions, it will fail, and this failure can take place even where the welder has built up the full cross-sectional area. Even where he has increased the cross-sectional area the failure can be traced to some of the conditions mentioned above which have not been taken into consideration.

Fig. 13. This Was Preheated in Blacksmith Furnace.

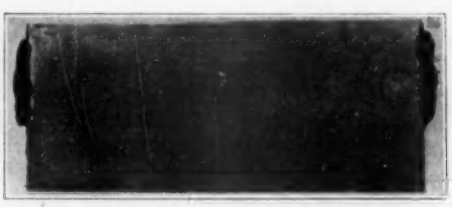

Fig. 14. Even Structure Secured by Annealing.

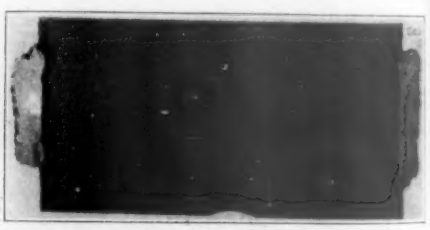

Fig. 15. Preheating Results in Hardened Zone.

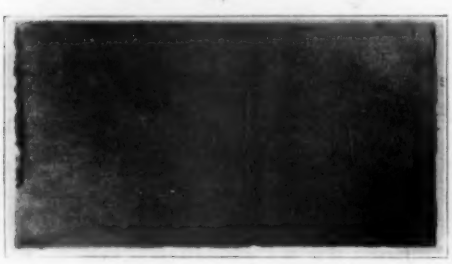

Fig. 16. Annealing Restores Uniformity.

Fig. 17. Metal Added Without Preheating.

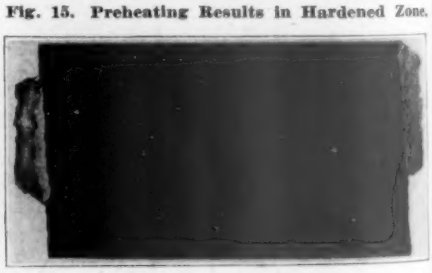

Fig. 18. Effect of Annealing Piece Shown in Fig. 17.

The procedure involved in carrying out the various tests will be mentioned in connection with the different illustrations. I

wish to call your attention to the fact that the hardened area in question will, in a great majority of steels, correspond to the same hardness as if the steel had been heated and quenched. The method of bringing out this hardened area or the structural difference in the steel visible without magnification, is the same procedure that can be used in checking up the extent of the hardened or tempered area in various tools, such as chisels, hatchets, etc., and is comparatively a simple method. The surfaces are given a rough polish and dipped in nitric acid of specific gravity 1.13, or where this is not practicable the acid can be poured over the steel.

As I understand, your meetings are conducted more or less in the round-table manner, perhaps it would be more interesting to show the photographs and discuss them as we proceed. Before doing so, I wish to say that I do not want to leave the impression that it is my opinion that all welds fail on account of the structural changes due to the heating, or that I am advocating not doing any welding at all, or that I am in favor of any one particular process of welding. All the various methods of welding have their proper fields, and a great deal of profitable work can be done with them. However, if the points mentioned will be taken into consideration by the party laying out the welding work, our welds will show fewer failures.

Fig. 19. Preheating with the Arc Did Not Improve Heat Action.

Fig. 20. Lack of Annealing.

Fig. 21. Change in Structure Due to Preheating with Flame.

Fig. 22. Effect of Annealing Piece Shown in Fig. 21.

In connection with the photographs which will be shown illustrating the hardened area and zones affected by the heat, in making some of the tests, test strips were taken so as to embody only the extreme, hardened zones, and further test strips were taken progressing into the unaffected metal. It was found that in the zones where the hardened condition was highly localized, these strips would not bend over 15 degrees before breaking or snapping off, but after annealing they could be bent flat on themselves the same as the original metal.

As an illustration of the application of the method of etching to develop hardened areas, the hatchet and chisel shown in Fig. 1 were first sand blasted and then dipped in nitric acid of specific gravity 1.13 for about a half a minute. Before this dipping the metal showed a uniform color over the whole surface, and after dipping it had the shaded appearance, as illustrated.

The maximum scleroscope hardness in the chisel in the darkened area at the cutting edge was 95, and this decreased to 55 in the body of the chisel.

In the case of the hatchet, the maximum hardness in the hardened area was 93 and decreased to an average hardness of 30 in the softest area of the hatchet.

A failed piston rod on which the cross head fit had been built up by the electric welding process is shown in Fig. 2. The photograph shows the added metal on the outer area around the circumference, and between this and the interior metal in the rod is an area scallop-shaped, affected by the welding heat. This represents the condition of the metal in the rod at the time of the failure.

The average scleroscope hardness of the added metal was 49, of the heat affected area 80, and of the metal in the rod proper 50.

The face of the saw cut opposite to Fig. 2 was taken and cut in two, both pieces being annealed, one-half being allowed to cool in the furnace and the other half in the air. It will be noted in Fig. 3 that the hardened area betwen the added metal and the parent metal has been eliminated.

The scleroscope hardness of the added metal in the upper piece, cooled in the furnace, was 38 and of the metal in the rod 55. The scleroscope hardness of the added metal in the piece cooled in the air was 38, and of the metal in the rod 57.

While the added metal in these two photos is shown in a black, shaded area, it should not be confused with the darkened area on the previous one, as in the latter two cases, this was a matter of etching in order to show the differentiation between the added metal and the metal in the rod proper.

The two photographs shown in Fig. 4 are the microphotographs of metal in the rod before annealing. Fig. 4a shows the added metal and the heat affected area in the rod, and Fig. 4b the normal structure in the center of the rod, all being shown at a magnification of 100 diameters.

Figs. 5a and 5b show the microphotographs (100 diameters) of the two pieces from this rod, which were annealed.

Both show added metal and the structure in the rod proper, the heat affected area having been eliminated by the annealing process, there being less segregation of the ferrite around the grain boundaries in the case of the piece cooled in the air than that cooled in the furnace.

Fig. 6 is another failed piston rod on which the cross head fit had been built up and shows the added metal and heat affected area in the metal of the rod.

In this case the hardness of the added metal was 51, that of the heat affected area 60, and the metal in the rod proper 45. Part of the hardness of the added metal may have been produced by cold working in service.

As a further illustration of the variation of this hardened zone, Fig. 7 is a cross-sectional etch of another piston rod where the cross head fit had been built up, the rod in question being heat treated nichrome steel originally.

Attention is called to the variation in the area of this hardened zone in the parent metal.

On comparison of the three plates of these rods, the one first

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shown shows an unusually uniform application and movement on the part of the welder; that is, uniform welding conditions. It had occurred to me that an etching method similar to this might be adaptable for grading or examining welders as to their proficiency as welders, and there would also be some indication as to the condition under which they were working.

Fig. 8 illustrates another piston rod on which the cross head fit had been built up, and you will note that the added metal has practically all been machined off or worn away.

I have heard remarks made at a meeting recently, wherein the party was apparently familiar with the fact that a hardening condition had been created through the welding; however, he stated that he did not feel that this finally resulted in injuring the material, as it was all machined off. If such was the case, it would not have been necessary for him to build up the fit, for to remove this, he would in reality be reducing the cross-sectional area below the normal fit. In this particular case, it may have been possible that in forming the taper on the rod, at this end of the rod all the added metal was removed, and at the other end of the fit some of the added metal would remain.

The next few photographs are taken of etches made in connection with the special investigation which was carried out to determine if a system of preheating would eliminate the hardened zones or heat affected areas created either through the preheating or the welding heat.

Fig. 9 is a crank pin, no preheating of any kind being done.

The scleroscope hardness on the added metal was 33, on the hardened zone 58, and on the rod proper 46. Metal added with electric arc.

Fig. 10 plate shows the previous piece after annealing the added metal showing a hardness number of 34, and the pin metal proper 45. Metal added with electric arc.

Fig. 11 is a piece of crank pin steel to which the patch was made after preheating the parent metal with the arc, resulting in the hardness numbers of 35 in the added metal, 50 in the hardened zone, and 47 in the rod. Metal added with electric arc.

After annealing, the hardened zones were removed, as shown in Fig. 12, and the hardness number in the added metal was 35, and in the rod 45. Metal added with electric arc.

The piece of pin shown in Fig. 13 was preheated in the blacksmith furnace and metal added by the electric process, resulting in the hardened zone as shown. The hardness number in the added metal was 34, in the hardened zone 59, and in the body of the pin 46.

After annealing, as in the previous instances, the hardened area was eliminated, as shown in Fig. 14, resulting in a hardness number in the added metal of 34 and in the rod 45. Metal added by electric arc.

Fig. 15 shows the same pin which was preheated with the arc, no metal being added, resulting in the hardened zone as outlined, of a hardness number of 64, and the body of the rod showing 44.

After annealing of the piece preheated with electric arc (Fig. 16), the hardness was uniform out to the edge of the piece, that is, 45.

Fig. 17 shows metal added around the section of a locomotive frame, metal added with electric arc, no preheating being done, the metal being added in three layers with the idea that the succeeding layers might exert an annealing action on the affected area.

The hardness number in the added metal was 34, affected area 57, and the parent metal 47.

After annealing the piece shown in the previous photo, the affected zone was removed, as shown on the right hand side of Fig. 18; however, on the left hand side you will note that a complete elimination of the zone had not taken place, accounted for by a too short period of annealing. Metal added by electric arc.

Fig. 23. Ordinary Welding Practice.

Fig. 24. Annealing Has Removed Affected Zone.

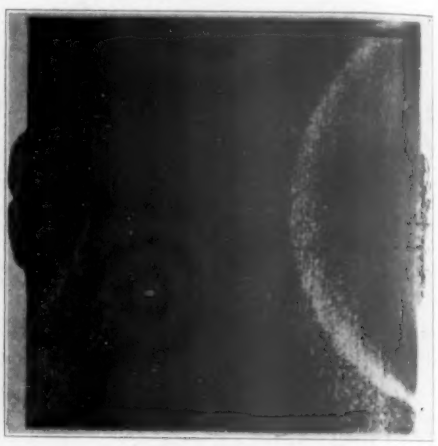

Fig. 25. Metal Added Without Preheating.

The same frame member was preheated with the electric arc and metal added, as illustrated in Fig. 19, the metal being added in three layers as in the former case, without showing any improvement in regard to the action of the welding heat.

Attention is called to the extension of action of the arc ahead of the added metal. In observing various hardened zones, it will be noted that the hardened zone extends about the same distance in front and back of the points where the welding operation starts and stops as it does beneath the weld. In a great many cases, in fact the majority, it appears that a fracture will start by an initial check through the affected zone, immediately back or in front of the weld or added metal, although there have been cases that unquestionably were a detailed fracture starting from the area underneath the added metal.

Fig. 20 illustrates the lack of annealing on the piece just shown and will serve to bring out the point that care should be taken to accomplish a thorough annealing. Metal added by electric arc.

Fig. 21 is a piston rod which was preheated with oxy-acetylene torch, no metal being added, resulting in the heat affected area as shown by the shaded zones with a maximum hardness of the affected zones of 53, whereas the normal hardness in the rod was 44.

After annealing, the piston rod previously preheated with oxy-acetylene torch, no metal added, showed a normal hardness of 45 throughout the rod section (Fig 22).

In the case shown in Fig. 23 the piston rod was preheated as per the regular practice and metal added with oxy-acetylene process, resulting in the affected zones, due to the preheating and welding heat, the hardness of the added metal in this case being 32 and the affected zones 53, the rod proper being 44.

Fig. 24 shows that on annealing the rod which had been pre-

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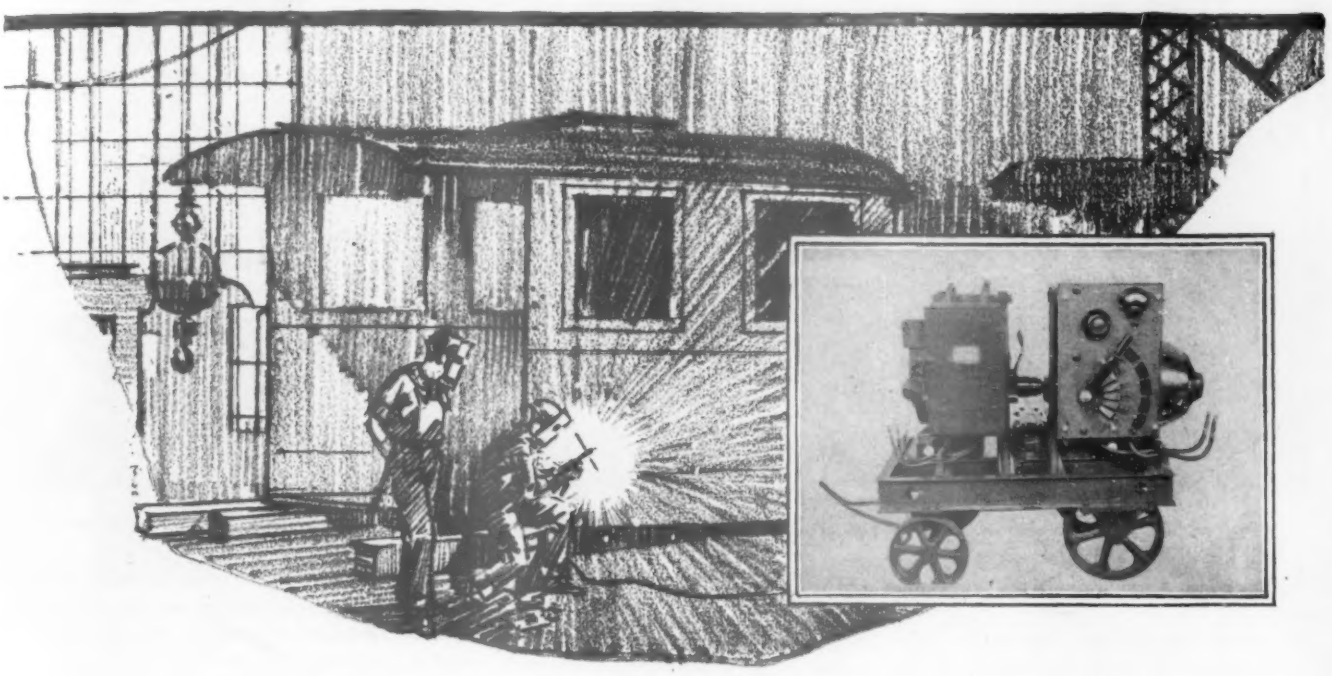

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heated as per standard practice, metal added with acetylene flame, the affected zones were removed, and the added metal showed a hardness of 34 and the rod 44.

Fig. 25 shows the same affected zones on adding metal by the oxy-acetylene process, no preheating being done, the added metal showing a hardness of 32, the affected zones 53, and in the body of the rod 42.

On annealing the rod to which metal had been added by oxy-acetylene process, without any preheating, the affected areas were eliminated (Fig. 26), resulting in a hardness number in the added metal of 35 and in the rod 45.

Fig. 27 is simply a further illustration of where metal is added by the oxy-acetylene process, no preheating, and afterwards annealed.

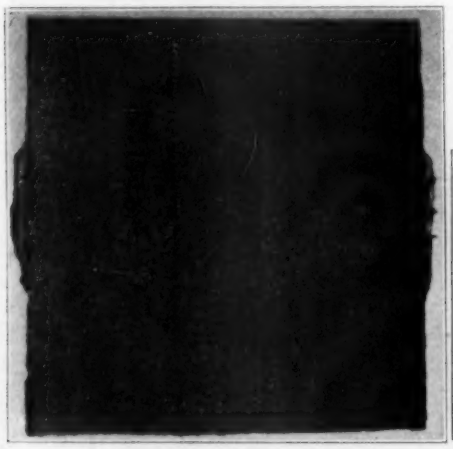


Fig. 26. Same Piece Annealed.

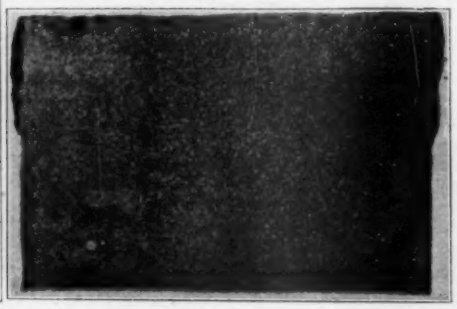


Fig. 27. Metal Added, No Preheating, and Then Annealed.

Fig. 29. Bolt Holes Cut with Torch.

The three views of the cross-section of a tire in Fig. 28 show the tire before the flange is built up by the electric process, and having a scleroscope hardness of 49.

After building up this flange by the electric process, the heat affected zone is created, the hardness numbers being as follows:

Added metal	18
Hardened area	67
Flange proper	48

The third view is after annealing, showing the elimination of the hardened zones, resulting hardness in the added metal being 20 and what was previously the hardened area 46, the tire proper being 47.

Fig. 29 is a photograph of a piece of rail in which bolt holes were cut with the acetylene flame. The piece was subjected to a transverse test, and you will note that in failure the fracture radiates out from the bolt holes.

Fig. 30 is a view of a section of the same rail previously shown, and shows a highly localized hardened area around the bolt holes, the Brinnell hardness of the affected zone being 321, as compared with the normal Brinnell hardness in the rail of 255.

The average of several transverse tests on some pieces of rail in which bolt holes were drilled showed an average depreciation of the transverse strength of about 25 per cent, and where these holes were cut with the acetylene flame, this depreciation was 38 per cent, as compared with the solid section, that is, an increase of 15 per cent over the cases where the holes were drilled.

Fig. 31 shows a cross-section through a crank pin which had been built up with the electric weld, resulting in an effected area around the circumference, and which showed scleroscope hardness of 48 in this zone, the added metal having a hardness of 38, and the body of the pin 38.

In the failure of this pin the hardened zone and added metal tended to shell off from the unaffected parent metal.

Fig. 32 shows a cast steel cross brace on locomotive frame, which is pulling away, the line of failure starting at the edge of the welded area, and investigations showed that this was starting in a check, developed through the hardened zone in front of the added metal.

In cutting the hole in the stub end of a rod, it was proposed to cut out this blank with the acetylene flame. The view of the piece so cut, as shown in Fig. 33, is a fair illustration of the condition in the extent of the zones affected by the heat of the cutting torch. It was proposed to carry out this process and then establish a process of reaming back a predetermined distance. However, in some cases this determined distance might remove all the affected metal, and on other areas, it would not, all depending on the uniformity and speed with which the cutting is done.

Referring to the remarks made relative to the practice in some shops of attempting to anneal local areas by covering the area

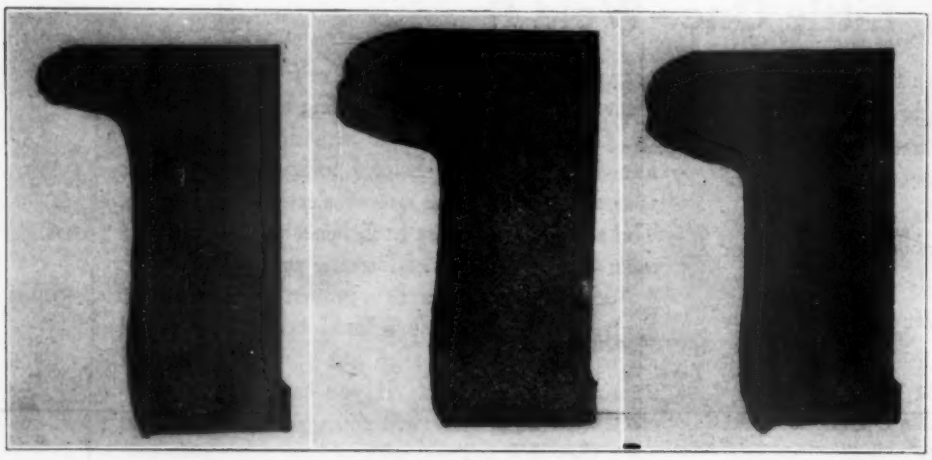


Fig. 28. Three Views of Tire with Flange Built up by Electric Arc.

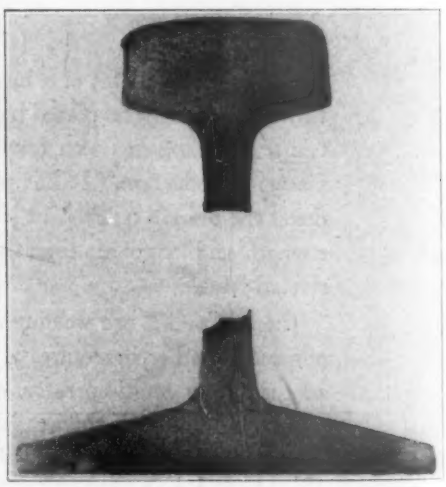
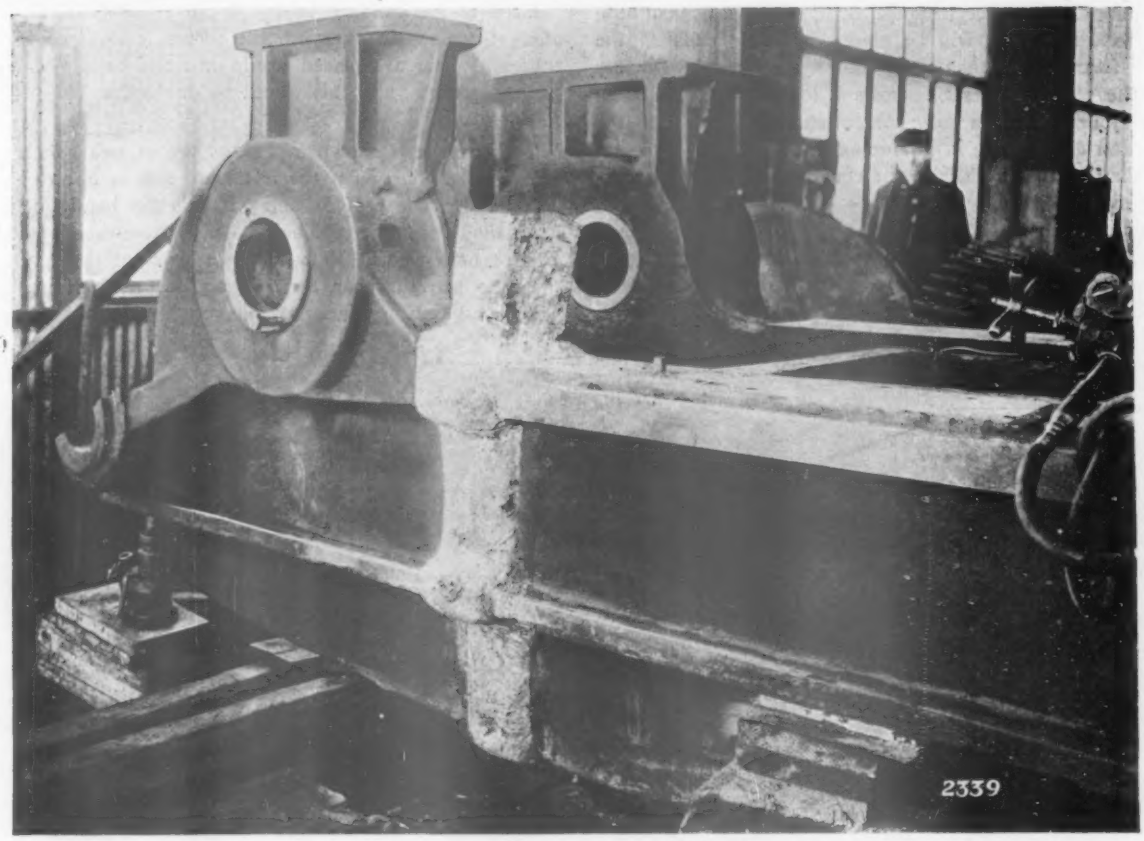


Fig. 30. Section of Failed Rail Showing Hardened Area.



Thermit weld on cast iron bed frame of a bulldozer machine, Magor Car Corp., Passaic, N. J. Section at break varied from about 4 in. x 14 in. to 8 in. x 21 in.

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Dredges
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Gas Engines
Gears
Gun Cradles
Hammers
Hoisting Engine Frames
Housings
Kettles
Ladles, Cinder
Mine Fans
Mine Hoists and Shafts
Mine Rake Shafts
Nail Machines
Oil Tank Cars
Peels
Pillow Blocks
Pinion Necks
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to be annealed in a blacksmith fire. A view of a longitudinal cut taken through an axle is shown in Fig. 34.

In reclaiming an axle, for instance, in upsetting a 5½x10 axle to make a 5x9, the axles will be placed with the ends of the axles in the furnace and then upset and worked in the forging machine. The view in question shows a longitudinal cut taken through the journal of the axle, and attention is called to the upsetting action on the axle in producing a more dense condition at the end than further back, also the curved sweep of the structure of the metal.

The longitudinal view through the axle in Fig. 35 extends back through the wheel seat, and you will note shows clearly the distance from the end of the axle which was heated sufficiently high to cause a change in the structure of the metal, and in this particular case there was a sharp demarcation between the affected metal and the normal condition in the steel. By proper annealing of the axle as a whole, this condition could be eliminated. The view, as stated, is a good illustration of what takes place on local heating either on forgings or castings and shows that local heating simply means transferring the structural changes from what might be classed as a local condition back along the forging or casting.

The photograph (Fig. 36) of the boiler tube welded in the plate and then etched does not develop highly affected zones, as shown in the previous views.

In these two particular cases, the hardness numbers of the plate was 45, in the tube 50, and in the added metal 45.

Even if the welding heat did cause unsatisfactory conditions along the lines in question, the service conditions in which the tube and plate are placed would in itself be a more or less annealing process, and this would no doubt take care of the points raised.

The two views shown in Fig. 37 are of two bolt holes from a cast steel casting. On the left hand side is one of the castings that has been in service, and on the right hand side is one that has failed in service. The hardened condition is shown in the case of both welds. Both of these bear out the statement made, that the man in charge of laying out the welding should see that all adjacent surfaces are thoroughly cleaned up in order to determine if a weld is justified, that is, does the metal show a porous, spongy condition, or are there shrinkage cracks, as shown in the upper left side of the hole in the unbroken piece?

Fig. 38 is a piece of a member of a truck side frame which had been welded up with acetylene flame, an unusually large area affected by the preheating and welding heat, particularly the white zone about the center of the section, which showed a penetration through the entire section. The metal contains an excessive porosity and this casting should, in my opinion, never have been welded unless it was possible to cut this area entirely.

Fig. 31. Cross-Section of Built-up Crank Pin.

Fig. 32. Line of Failure Starting at Edge of Welded Area.

Fig. 36. Welded Boiler Tube.

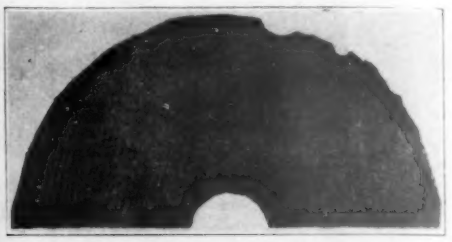

Fig. 33. Extent of Hardened Area Depends Upon Operator.

Fig. 37. Surfaces Should Be Cleaned to Show Condition of Metal.

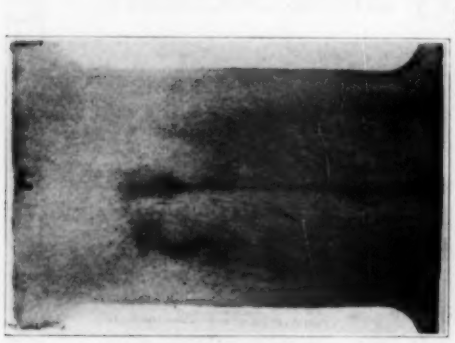

Fig. 34. Longitudinal Section of Axle Heated and Upset.

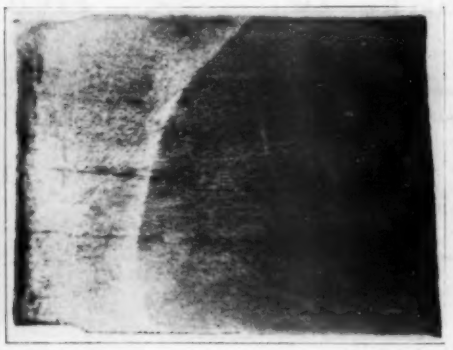

Fig. 35. Proper Annealing Would Improve This Piece.

Fig. 38. This Metal Was Not Fit to Be Welded.

FIGHTING ICE WITH STEAM

No one who was in New York last winter has forgotten the long and trying siege of snow and ice that the city passed thru. Inconvenience to the vehicular and pedestrian traffic was the most apparent phase of the experience, entailing loss to business computed in the millions. However, there was another very serious angle to the situation which was but little known to the general public. That was the danger that fires would attain serious headway, owing to frozen hydrants before the firemen could get water into play on the flames. Danger of this kind, resulting from difficulty in thawing out frozen hydrants is to be greatly minimized this winter, if a device invented by Mr. Louis F. Rose and manufactured by The American-La France Fire Company proves as great a success in service as is hoped by the New York Fire Department.

Asked what device his invention would supersede or improve upon, Mr. Ross said: "Until now there has been no device, no adequate way of dealing with frozen hydrants so as to get water into play on burning buildings without very serious delays in case of hydrants being frozen which is very common in all Northern cities in the winter months. Many ways of thawing out frozen hydrants have been tried. Fire, boiling water and steam have been applied in many ways, but thus far only successful means is to combat ice with steam as is done in the device I have perfected."

The Ross Hydrant Thawing Device was given its initial demonstration the other day before an interested party of Fire Department officials and men at the Repair Shop of the New York City Fire Department at Fifty-sixth Street and Twelfth Avenue. The device may be briefly described as a steam coil surrounded by a jacket tank, which is filled with water for pumping into the steam coil. The heat for generating the steam is provided by a burner directly under the coil. The burner has ten jets, the fuel used being acetylene. In one of the accompanying pictures, a tank is clearly shown attached to the steam generator and another cylinder is seen near-by in readiness for connecting when the pressure in the first cylinder runs too low for effective operation of the device. This situation would occur only in demonstration where a great deal of thawing is done. In actual practice, one cylinder would be ample for opening

Cutting Ice With Steam.

up any number of hydrants likely to be used at any fire. The only other necessary part of the device, and this is also shown in the picture, is a connecting hose, one end of which serves as a nozzle to direct the steam jet in the thawing process. As soon as the acetylene jets are lighted, the operator begins pumping water slowly into the steam generating coil and the intense heat of the acetylene under pressure not only converts the waters into steam almost instantly, but superheats the steam so that it is what is known as "dry steam", having a temperature corresponding to that of steam produced by superheaters in locomotives. As the hose gives a permanently open outlet for the steam, no safety valve is required, but one is attached as an added safeguard. Water is fed continuously into the coil, being converted into steam precisely as is the case when a drop of water falls on a red hot stove.

It will be noted that there are two operators for the device, one working the hand pump to feed water to the steam coil and the other one handling the hose in the thawing process. The blocks of ice shown are approximately twenty-four inches high and weigh about one hundred pounds each. The pictures were snapped a few seconds after the thawing was begun and a few seconds later the ice was penetrated to the ground. Observing the progress of the hose, one was given an impression of thrusting a stick thru some gently yielding or jelly-like substance.

In one of the pictures a man is seen standing on the rear of a truck to which two uprights have been fastened with rope.

Clearing Hydrant Pipes of Ice.

These uprights are really hydrant pipes some five or six feet in length and as many inches in diameter. They were artificially frozen for this demonstration. Owing to some trick of the light, the hose is not completely shown, but it was held in the hands of the operator and thrust slowly from top to bottom of the hydrant in exactly twenty-five seconds, thus demonstrating how easy it would be to open a frozen hydrant in emergency at a fire.

The witnesses to the demonstration were very much impressed and it is likely that this device will be one of the features of fire fighting apparatus that will be seen in action in New York this winter.

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Give the Welder a Chance

IN a current editorial, the *Railway Mechanical Engineer* says:

"The so-called fusion welding processes have received a remarkable rapid development and extension in the comparatively few years since their introduction as regular features of railway equipment maintenance. As a natural consequence of this rapid development, a reaction has become evident in the minds of some of those who have to do with the results as applied to locomotive and car parts. This is not necessarily serious, but it is a warning that the future extension of the art must be based on a far more thorough study of the conditions to be met by the welds, of welding methods and practices, and of the metallurgical aspects of welding, than has been devoted to the subject in the past. Fusion welding has passed through its pioneer development and must now be reduced to a science.

"The greatest obstacles in the way of stabilization and sound future extension of these welding processes in the railroad shops are the provisions of the so-called National Agreement, which makes them mere adjuncts of the other crafts. Under this agreement, welding must be performed by machinists, boiler makers, blacksmiths, tinsmiths and carmen, and by its provision, the qualifications which control in the selection of welders is seniority of employment as a craftsman in one of the other trades. Under these conditions it is manifestly impossible to maintain the degree of permanency in the welding forces essential to the development of highly skilled and experienced operators; the kind of work assignable to each welder limits his experience and outlook and the supervision is divided among the regular shop foremen, to none of whom welding is a primary interest.

"The short time in which one may acquire a sufficient degree of skill in the manipulation of the torch or electrode so that he may "get by" is possibly one of the most potent factors in the rapidity with which the processes have come into general use. But it also constitutes one of the greatest dangers to sound future development. One of the best ways of avoiding this danger is to organize fusion welding work as a trade by itself, for training in which men may be selected who have the proper temperament and whose purpose is to make welding a permanent vocation. Not only will this lead to the development of more skilled operators, who in time will supplement their skill with more or less knowledge of the metallurgical questions involved, but better supervision will become possible because of the concentration of the work in a department by itself and because the craft training of the welders will provide the material from which competent supervisors may be selected. The possibilities for economy in the railroad shop offered by these processes are too great to permit the strangling of their future development by the permanent establishment of conditions under which they must now be applied."

Fusion welding is attracting more and more favorable attention on the part of the railroads, and it is time that the welder himself began to get more of a square deal. *The Welding Engineer* has received a number of letters from welders in railroad shops expressing the same sentiment as the above editorial.

Send Back the Empties

USERS of bottled gases should bear in mind that prices are figured on costs, and that a little attention on their part will cut the costs of some of the things they use, particularly their gases. A few dollars' worth of acetylene or oxygen is shipped in a metal tank that is worth five or six times the value of the contents, and the tank, when empty, is often allowed to stand around waiting for a rainy day, or some other equally good excuse, before returning it to the manufacturer, who has thousands of dollars invested in these containers. If tanks are not returned promptly the manufacturer simply has to have more of them made, and the interest on this investment is part of the cost of delivering the gas to the welder. An empty tank is of no use in your shop. Send it back promptly, and help keep down unnecessary costs.

Quick repairs to the smashed bow of one of the United States Emergency Ship Corporation's vessels

The Rivets Have Been Burned Out

CONSIDER the ease with which Oxy-acetylene accomplishes the most trying operation that comes to any ship-yard—repair work on framing and plating.

Compare this modern method of cutting out rivets, of severing frames, of sundering plating to the obsolete method of the cold chisel, drill and hack-saw. It's like comparing the craft of Columbus to the enormous ships of to-day.

In the ship-yards, in fact wherever welding and cutting is done

Prest-O-Lite

DISSOLVED ACETYLENE

The Universal Gas With The Universal Service

is the *one* supreme gas to use in welding and cutting operations.

And advantageous as this ease of cutting out damaged parts with the oxy-acetylene blow-pipe is, this splendid tool has also the power to join the metals together again, and the joining will have all the qualities of the metals joined.

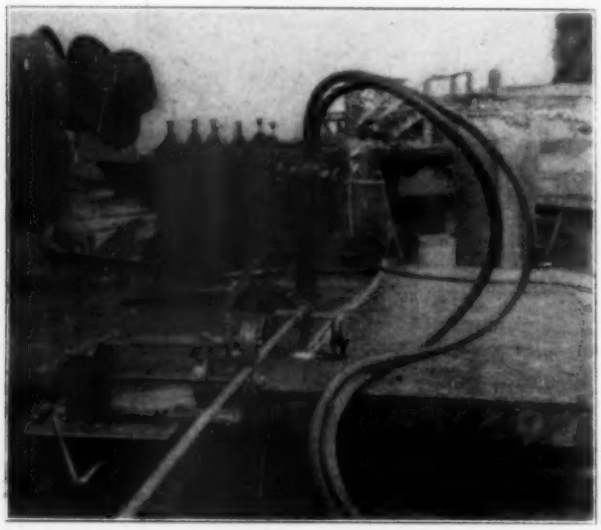
There are so many reasons why Prest-O-Lite is especially adapted for the particular work of ship-yards that we invite you to ask us all of them.

THE PREST-O-LITE COMPANY, Inc., Carbide and Carbon Bldg., 30 E. 42nd St., New York
Kohl Building, San Francisco
In Canada, Prest-O-Lite Co. of Canada, Limited, Toronto

PW 505

SEMI-AUTOMATIC CUTTING TORCH

A machine for operating the oxy-acetylene cutting torch was given its maiden test in industrial service recently at the government proving grounds, Sandy Hook, where it was put through its paces in the presence of engineers of the Development Department of the Linde Air Products Company and a group of practical operators from the Oxweld Acetylene Company's Newark welding shop. The latter company some time previously had entered into a contract to reduce 4,000 tons of punctured armor plate to charging box sizes, and the new machine was developed in an effort to effect economies in the oxy-acetylene process involved. The test was an unusual one and a revelation to the engineers and operators alike.



Semi-Automatic Cutter in Action.

The particular problem involved in the Sandy Hook job was to devise, if possible a semi-automatic mechanical means of cutting irregular surfaces. The armor plate was badly warped by the impact of the shells which had pierced it in target practice, and the puncture (six in each plate) were mushroomed and ragged. Each of the plates (3 in. thick by about 9 ft. x 13 ft.) weighed between seven and eight tons. Besides irregularity of surfaces, another difficulty loomed large in the metallurgical composition of the metal, which contained high percentages of nickel and chrome. This kind of steel yields a heavy and viscous

Cut Through a Three-Inch Plate.

slag that does not flow freely from the kerf in oxy-acetylene cutting. This not only retards the cutting speed but necessitates higher oxygen pressures than are required in cutting ordinary steel of the same thickness.

The engineering difficulties, however, were quickly overcome and a completed test machine was on the job within a week, so that any economies resulting from machine cutting would effect a material saving on the contract. It is estimated that the savings on this one contract will more than pay for the machines. In the meanwhile it is anticipated that the new applications will be developed, as machine cutting of irregular surface is an important economy measure in wrecking operations.

The inventor of the machine describes it in the following rather technical terms:

The power for operating the machine is furnished by a General Phonograph Company spring motor. On the turntable splindle is a worm. In mesh with the worm is a 72-tooth worm wheel on a horizontal shaft running in two bearings. On the outboard end of this horizontal shaft is fastened a knurled-groove pulley. Above is another and larger knurled-groove pulley which is held down by spring tension. Through these two rollers pass jointed knurled pull-rods of which the out end is attached to a torch carriage. A lever is attached so as to pivot on the idler roller shaft and, when raised to a vertical position, applies a brake to the lower driving shaft, at the same time separating the two rollers, giving freedom to the knurled pull-rod. The usual phonograph speed control is used. A change is made in the governor weights of the motor to run faster. This, together with the large gear reduction provided, gives a greater towing power to the pull-rod. A machine cutting torch is mounted on a two-wheel cart having wheels 3 inches in diameter. The wheels are made of cast iron and the bearings and wheels are protected from sparks by metal shields. Runners are provided on each side set close to and inside of the wheels. The runners are three inches in length and are mounted to clear the plate ⅛ inch. Their function is to prevent the torch carriage from falling off the plate at the start and finish of the cut. The combination of the two-wheeled cart with swivel connection to the pull-rod keeps the tip of the torch at the correct dis-

One of the Bad Pieces.

tance from the surface of the plate at all times in spite of the irregular surfaces of the warped armor, and the cut is thus kept at the correct angle to the plate. A "C" clamp attaches the motor to the plate and may be moved to a new line of cut by releasing the hand set-screw.

This is a rather imposing description of a device that is scarcely more complicated than a bucksaw, though it sounds as intricate as the specifications for a battleship. The entire equipment does not weigh over 30 pounds. In "setting up" all that is necessary to adjust the alignment is to place the motor so that the pull-rod extends over the line of cut, as the rod is always in the direct line of cutting. Changing to new lines of cut is almost as simple as moving a typewriter from one desk to another.

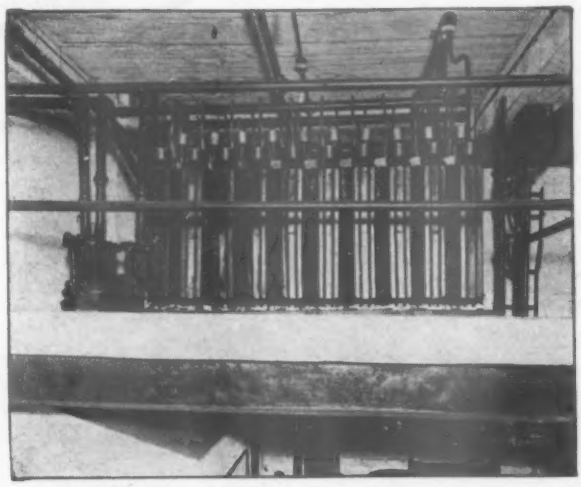
It would be interesting to pit the machine against an expert hand cutter in a test of speed and gas consumption, but it would be hardly fair to the hand cutter because the machine has no nerves to yield to fatigue. Its greater speed is largely due to its steadiness, as is also its saving in gas consumption. It makes a clean, straight kerf, which is the technically economical cut, and its advance is as regular as clockwork. So long as its spring is wound and the brake released it will run. The ultimate promise of the new device undoubtedly is in the fact that with it the unskilled and inexpert cutter can accomplish as much as the most experienced hand cutter—a fact that will make it a big factor in its particular field.

This Is The LEVIN CELL

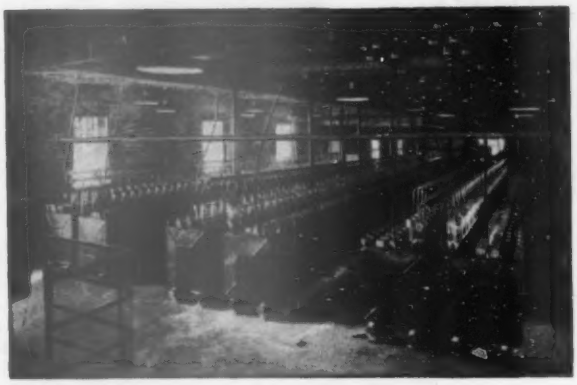
Each Levin Cell is a complete generating unit. Each Electrolabs System is a battery of Levin Cells, just enough of them to produce the amount of gas you require. As your requirements increase, simply add more Levin Cells to your present installation.

Levin Cell installations are simply constructed and easy to operate. They eliminate gas worries, such as handling tanks, delayed shipments, lost tanks, keeping tabs on full and empty tanks, running out of gas at critical moments, etc. Your oxygen is always ready when you want it, and it is the purest oxygen that can be made.

Simplicity
Economy
Dependability
Safety
Efficiency
Convenience



Here is a small installation of 20 Levin Cells, tucked away on a balcony and producing oxygen at one-third the cost of bottled gas.



This installation of several hundred Levin Cells produces oxygen in large quantities and represents an enormous annual saving to the user.

We will be glad to submit proposals on installations of any desired capacity.

THE ELECTROLABS COMPANY

2635 PENN AVENUE — PITTSBURGH, PA.

Branch Offices
30 Church Street
New York City

Electrolabs
ELECTROLYTIC GAS SPECIALISTS

Morris Building
Philadelphia, Pa.

Merchants Exchange Bldg.
San Francisco, Calif.

Under the Technical Supervision of Electrolytic Oxy-Hydrogen Laboratories, Inc.

Smith's Complete Ox

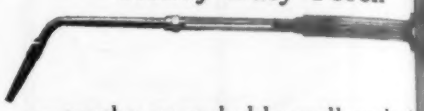
Smith's No. 4
Pistol Grip Welding Torch

This torch is economical,—easy to handle and operate,—and is made in 14, 18 and 22 inch lengths. It may be instantly made into a cutting torch by merely removing the welding tip and inserting a cutting tip.

Note the oxygen valve right under your thumb, where you can adjust the flame as you work.

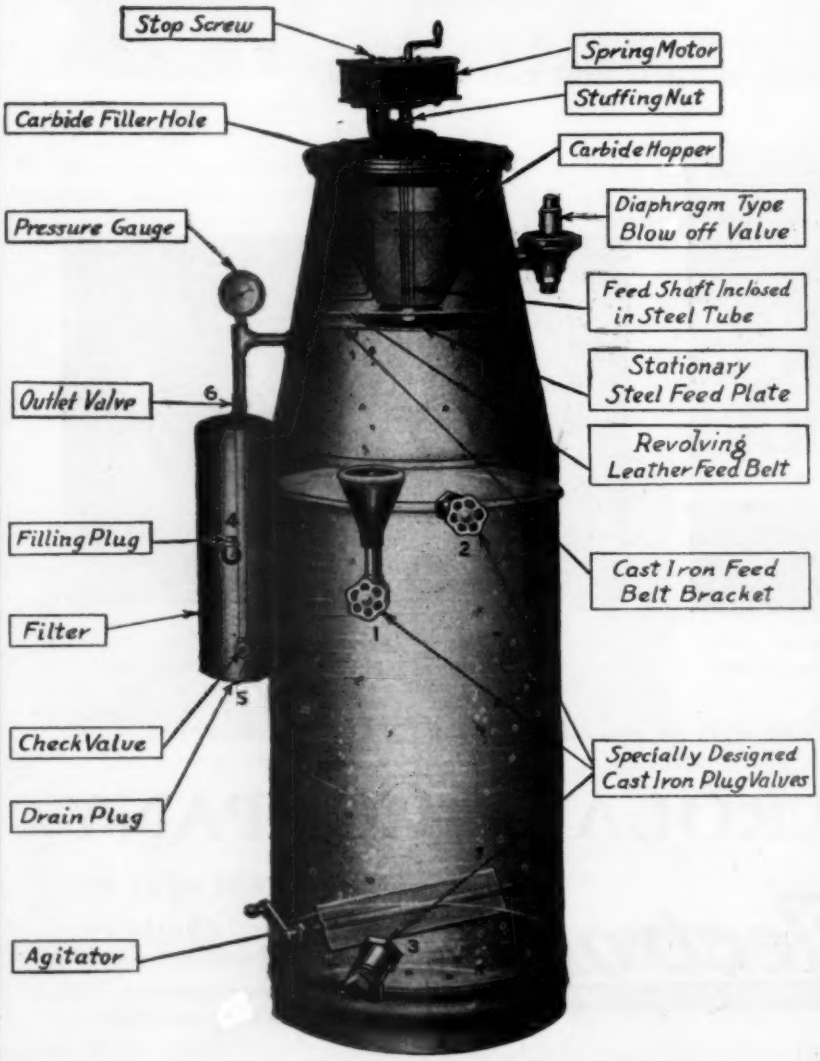
Ask Your Neares
Jobber for the
Smith Line,
Write Us Dire

Smith's No. 6
Heavy Duty Torch



—works remarkably well under l
pressure,—produces a soft fla
ideal for cutting risers on castings,
and stands up under severe u
A cutting tip is furnished to c
to 6 inch steel.
This torch has the n
flash-back feature a
the cutting-tip t
are exclusiv
Smith features.

Smith's Automatic Acetylene Generators



Made in
30, 50, 100 and 200
lbs. Carbide Capacities

Generates Acetylene At 1-3 Its Cost in Drums

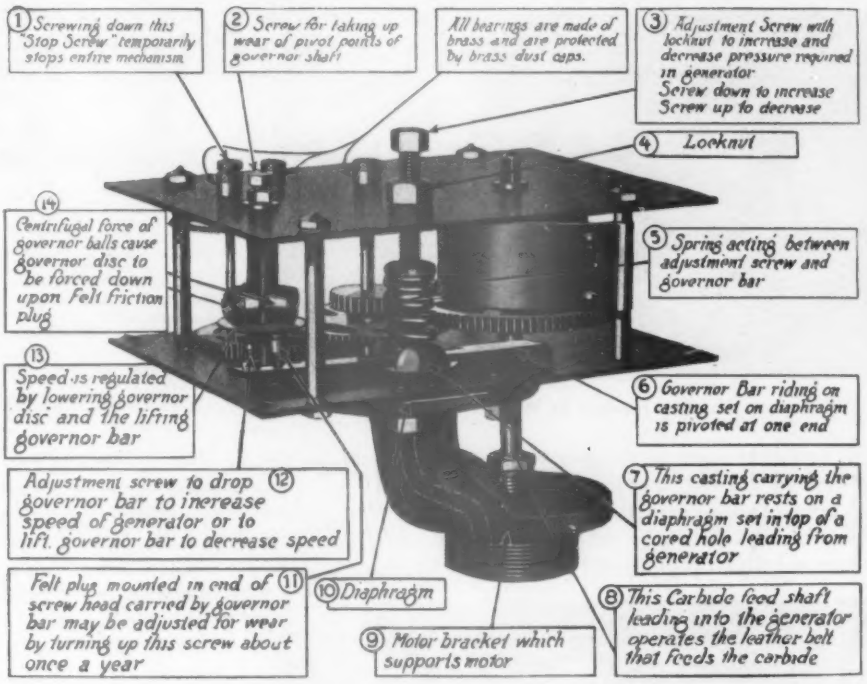
With Smith's Automatic Acetylene Generator you can generate your own acetylene right in your own shop at one-third of its cost in drums. One of these generators will free you forever from having to depend on uncertain deliveries of gas in drums.

A Permanent Acetylene Pla

A Smith's Generator generates acetyle
only as fast as the reserve supply is used.
operates at whatever pressure is needed, a
is adjustable to almost any requirement.

Acetylene Equipment

Smith's equipment for welding shops is a complete line, from complete generator plants to the smallest accessories. The MERIT and DEPENDABILITY of the Smith line has been proven by years of successful service in shops everywhere.

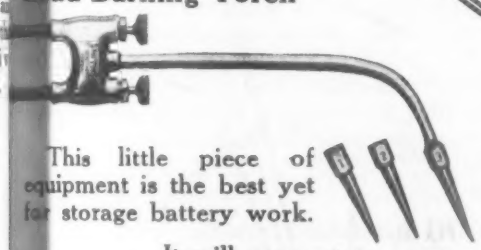

1 Screwing down this "Stop Screw" temporarily stops entire mechanism.
2 Screw for taking up wear of pivot points of governor shaft
All bearings are made of brass and are protected by brass dust caps.
3 Adjustment Screw with locknut to increase and decrease pressure required in generator. Screw down to increase. Screw up to decrease
4 Locknut
5 Spring acting between adjustment screw and governor bar
6 Governor Bar riding on casting set on diaphragm is pivoted at one end
7 This casting carrying the governor bar rests on a diaphragm set in top of a cored hole leading from generator
8 This Carbide feed shaft leading into the generator operates the leather belt that feeds the carbide
9 Motor bracket which supports motor
10 Diaphragm
11 Felt plug mounted in end of screw head carried by governor bar may be adjusted for wear by turning up this screw about once a year
12 Adjustment screw to drop governor bar to increase speed of generator or to lift governor bar to decrease speed
13 Speed is regulated by lowering governor disc and the lifting governor bar
14 Centrifugal force of governor balls cause governor disc to be forced down upon felt friction plug

Motor Used on Smith's Generators

This illustration shows the spring motor used on Smith's Generators, with the dust-proof case removed.

Study its parts, and note the fine mechanism and the finished workmanship.

Smith's No. 12 Lead Burning Torch



This little piece of equipment is the best yet for storage battery work.

It will connect to oxygen and acetylene drums, and is an ideal accessory tool with Smith's special Welding, Cutting and Carbon-Burning plants.

Smith's Soldering Coppers

—are for use with acetylene drums or generators, and are furnished for use with city gas. This tool can be used not only for soldering, but also for brazing, sweating, and silver and aluminum soldering.

SMITH'S INVENTIONS INCORPORATED

261 74th St., S. E., Minneapolis, Minn.

REPAIRING LIPS AND BOTTOMS OF STEEL KETTLES

Owing to the nature of the smelting process followed at the Nickelton, Ont., plant of the British American Nickel Corporation the slag obtained sometimes runs high in mattee, the action of which is very destructive to steel kettles, tending

The Patches in Place.

to wash away the steel at the point of contact and injure the kettle beyond further practical usefulness.

The company has recently been getting economical results by reclaiming its kettles by means of Thermit welding. The accompanying illustrations and sketches give an idea as to the

Before Removing Risers.

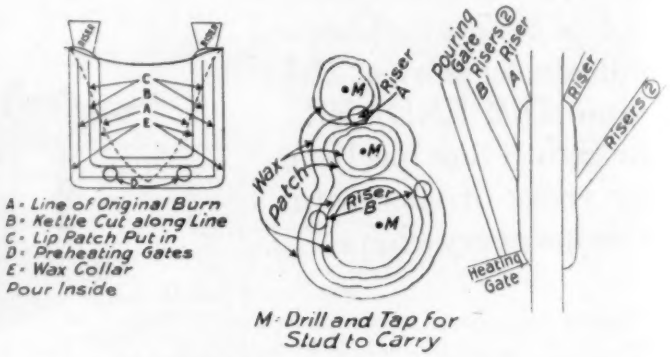
work done. In both cases described pieces of steel were forged and welded to the kettle rather than completely filling up the burnt areas with Thermit steel. By this method undue contraction strains were minimized.

In the case of the kettle with the holes in the bottom three

Finished Weld.

patches were made instead of two, as shown in Figure 1, owing to the irregularity of the holes and the facility of making two patches easier than one irregular patch. In lining up the patches approximately 1 inch was provided at the edges for the entrance later of Thermit steel. These patches were surrounded by a yellow wax pattern and the usual Thermit welding practice then followed.

In arranging riser patterns these patterns were used both inside and outside, one coming off at the high point and two others placed about half way down on the wax. These latter two served to take care of the shrinkage of metal when the weld started to cool.



The welding of the bottom was spread over two operations, owing to the fact that there was insufficient material on hand to complete the job the first time.

In the case of welds made on the sides of kettles care must be taken not to put too much stock in the collar of the weld. Otherwise there would be a tendency to retard the clearing, or so-called skulling of the kettle. In applying the wax collar the wax should be from ⅛ in. to ¼ in. fuller than finished shape in order to allow the shrinkage during contraction.

In forging the lip patch the blacksmiths followed the outline of the cut material, cutting and shaping it to provide a space of about 1 in. It was no small job to shape the patch, and it is believed that in future repairs of this kind time can be saved by cutting away the kettle to a square shape as shown in one of the sketches. The lower portion will not then lend itself readily to melting down during the preheating operation. It may also be preferable to cast the lips of steel rather than forge them.

A NEW BLUE FLAME OIL GAS BURNER

A novel invention for burning oil in place of small coal fires and gas burner is now being placed on the market. The Hauck oil gas burner converts ordinary kerosene or coal oil to a perfect combustible gas, producing a clean, blue flame. One of the many features of this burner is that the so-called "flare-back" eliminated, also that the flame is odorless and noiseless.

The burner when in full operation can be safely covered with a sheet of metal or asbestos so that the flame is prohibited from expanding fully. This makes this burner particularly suited for operating in close quarters where safety is required.

The oil consumption is but three pints per hour at maximum and can be throttled to consume but two pints with a relative smaller size flame produced. The amount of heat generated by the burner which produces 141 small blue gas flames and which can be increased until these flames increase and converge into one large triangular flame six inches in height makes it a very practical outfit any place where a clean, noiseless flame is desired.

The outfit consists of a five gallon steel tank with fittings, for holding the liquid fuel, equipped with a hand pump for forcing the oil to the burner by means of air pressure at 30 pounds; six foot length of copper oil tubing and the burner proper. Burner is 14 inches long x 6 inches wide and 5 inches high.

VICTOR
TRADE MARK

Welding and Cutting Apparatus

VICTOR welding and cutting apparatus is now sold at the following cities:

Chicago, Ill. **Portland, Ore.**
Detroit, Mich. **El Paso, Texas**
San Francisco, Calif.

SAN DIEGO CONSOLIDATED GAS & ELECTRIC COMPANY
H. M. BYLLESBY & CO.
MANAGERS AND ENGINEERS

ADDRESS ALL CORRESPONDENCE TO THE COMPANY

SAN DIEGO, CAL.

May 5th, 1919

File: 444.3

Mr. F. W. Clifford,
Victor Oxy-Acetylene Equip. Co.,
884-886 Folsom Street,
San Francisco, Calif.

Dear Sir:

Replying to your letter of April 30th, 1919, so far the water cooled torch has done all that you claim for it and our welder, Mr. Black, is very much pleased with the work. He says it is the first time that the "Bunk" handed out by the representative of a welding torch ever came true. We have only had occasion to use it on a number of small jobs, but found it very satisfactory. One job we feel certain we would not have accomplished with old torch. We had a truck cylinder block that had two scores about ¼" deep and 8" long. The walls of the cylinder were only about 5/16" thick. This work was done with the No. 8 tip and after job was completed, we found the cylinder a little out of true but found it O. K. after cylinder was rebored, and we could hardly detect the new metal from the old. We placed order with purchasing agent for one set of tips, No. 1 to No. 7 complete, requisition for which should reach you within the next day or two.

I thank you for the instruction book, also for your offer to furnish information on handling difficult job. Would be glad to have you drop us a line a day or so in advance when you expect to make your next visit.

Yours very truly,

SAN DIEGO CONS. GAS & ELEC. COMPANY,

Sup't Shops & Stores.

CDW:AT

These are only a few of the points where *Victor* apparatus will be sold in the future

Because wherever *Victor* goods are introduced they are there to stay—and repeat orders follow.

WHY?—Because *Victor Torches* do the most work for the least money and fulfill all promises made for them, as indicated by this letter.

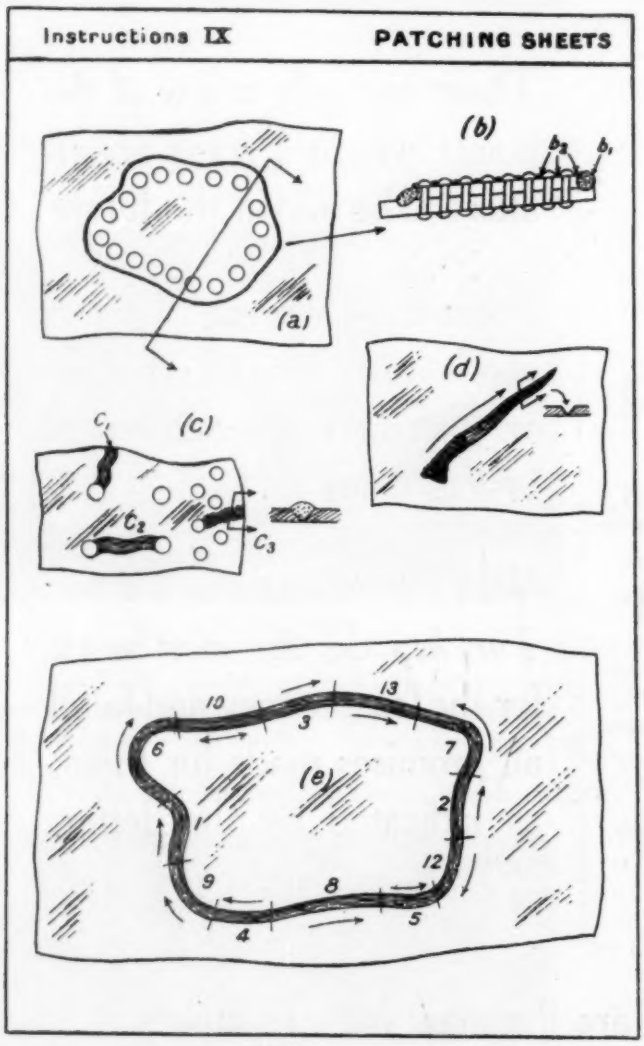
Distributors Wanted. If you are the man you can build up a very profitable business selling Victor Apparatus. Eliminate the above cities and select your own territory.

Victor Oxy-Acetylene Equipment Company

10 North Jefferson St., Chicago, Ill. **884 Folsom St., San Francisco, California**

PATCHING SHEETS

IN Figure E, which is really a continuation of Instruction No. 8, i. e., the completion of the patch tacked, the same system should be applied in completing the weld as in tacking, i. e., weld opposite sides successively on the vertical sides, proceeding as in tacking except that after the tack has once been made there is a choice of using the method outlined previously of welding beads in layers, which undoubtedly is the best method to follow where it is applicable. There should not be an excessive pad added to a sheet in the firebox, as the excess metal would act somewhat like scale on the back side of the sheet in not allowing the quantity of heat conduction uniformly on the sheet, and cause crystallization, which is especially liable in a weld; as a weld must always be considered a steel casting, however, it is electrically cast steel which is far superior to any other steel, and furthermore, welds made carefully in successive layers or in full fillet made continuously, i. e., the equivalent of successive layers, the entire mass is annealed by the heat of the arc,



each layer protecting and annealing the layer underneath.

Figure E shows the sequence of the sections to be welded and also the directions of welding in each section, the idea being to balance the forces of contraction and expansion of the weld and plate material. There are several detail methods, one known as the back-step method, in which welding is accomplished by a series of short sections welded back towards the starting point, or the balance method as explained in tacking and the first of this lesson, the idea in each being to mix up the application of the heat and the resulting strains so that not too great a stress will result at any one point. The welding of a sheet in a firebox with the fire on one side and steam and water pressure on the other side is the highest development in arc welding yet obtained, as welds of this type have been successfully made in locomotive boilers which are further subjected to a continuous succession of the blows of oscillation and concussion in the locomotive rattling over uneven road bed, frogs and switches. This is the equivalent of a fatigue or shiver test where the slightest defect would show up in a serious failure.

Figure A, Instruction 9, shows the method of putting in a patch which replaces the caulking of a purely riveted patch. The section showing to the right, i. e. Figure B, shows the patch applied and a sealing fillet around the entire edge, and in most cases where this kind of a patch will be encountered is where a riveted patch has been applied and later starts to leak. The patch should then be tightened up once more and the fillet run along the entire edge equal to the section of the plate and a weld applied to each rivet head on the accessible side, thus sealing any possible chance of leakage at any point. All rivets should be welded even if only one or two show signs of leakage, as the tightening up of the leaking part transfers the strains to the others. A further case of welding in a boiler is welding round leaky staybolts, in each case they should be chipped clean and as nearly tight or rigid as is possible before welding, as, in general, there is not enough chance to add welded metal equal in strength to the staybolt or rivet and plate.

Figure C shows cracks which occur in a boiler usually from rivets or staybolts to the patch or between rivets or staybolts, and as shown in the sections to the right the cracks should be veed out exactly as in welding a patch, and welding from the start to the edge; and where starting from a rivet or staybolt the staybolt to rivet and adjacent staybolts or rivets should be welded, also after being made tight.

A Crack in an Open Sheet.

Figure D shows a very hard case, i. e., a crack in an open sheet not starting from a rivet or patch. There is a very good reason for this crack, which reason sometimes precludes the use of welding as a remedy for it. If the life of the metal has been burned out from overheating through scale or for any other reason, subsequent efforts at expansion may cause a crack to relieve the strain. If the metal has been severely overheated or burned, although a good weld may be made by veeing out, as shown in the cross section to the right, upon subsequent contraction either directly after welding or later when in service a smaller crack may appear alongside the first one. This, obviously, is not the fault of welding, and, in fact, the method to pursue is to weld the crack as carefully as is possible once, and if it cracks again cut out the entire ruined section, which can be tested by successively drilling until good metal is found, the holes being included in the section cut out. There has been used in cracks of this kind a hole drilled at each end of the crack to prevent the crack from extending, but if the crack is finally chipped out, i. e., chipped into the plate beyond all traces of the crack, this drilling of hole is not necessary, i. e., not even desirable. If the crack is a long one, welding at the two ends should be accomplished first, and for extra long, one section in the middle, i. e., method similar to welding the patch as described previously. A very common crack to occur in a boiler is in a flue sheet at the upper or lower patch where successive rolling has expanded the sheet beyond the limit of its endurance, i. e., beyond its elastic limit. Cracks caused by this can generally be successfully welded.

*Instruction No. 9 from the handbook of the Electric Arc Cutting & Welding Co., 222 Halsey Street, Newark, N. J. Copies of the complete instruction book may be had from this company at $1.25 each.

Good Welding Production

—and fine workmanship often are merely a matter of eye-comfort to the welder. The Willson Triangular Welding Goggle, Style L1, keeps out all sparks and permits free ventilation. It is equipped with latest comfort features, and all parts can be replaced without a tool.

Approved by The Underwriters' Laboratories. The lenses meet safety code requirements by Bureau of Standards Test

Price $300.00 per hundred, f.o.b. Factory. Write on your company letterhead for a trial goggle.

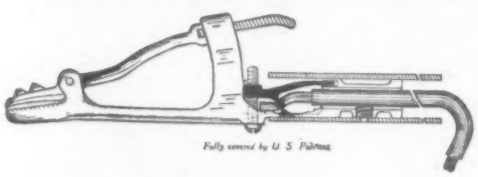
Willson Goggles, Inc., Reading, Pa.

The world's largest factory devoted to manufacturing eye-protective devices exclusively

Attention Electric Welders

The First Real Electrode Holder on the Market

THE UNIVERSAL



Positive grip through both jaws, universal grip between jaws. Length 12 inches. Weight 1¼ lbs. Air cooled handle.

Constructed of manganese bronze and wood fibre. Hand does not come in contact with metal while welding.

A saving of 75% of time by the trigger release of hot waste material.

In feeding or installing new electrode, operator's hand never comes in contact with hot metal.

For Sale by All Leading Jobbers

MANUFACTURED BY

ROY O. WILLIAMS

946 Livingston Ave. Columbus, Ohio

DON'T LOSE TIME

When Dressing the Weld

Because of **HARD SPOTS**

Make It Easy to File or Machine

Please Your Customers, Satisfy Yourself

USE

SOFT-Y TRADE MARK WELD

FLUXES

For Cast Iron, Brass, Bronze, Malleable Iron and Steel.

Soft-Y-Weld Will Cleanse the Metal, Prevent Blowholes, Make a Strong Weld and Leave It SOFT

TRY IT

Write for Price and Free Sample

The Blackrock Mineral Company

DENVER, COLORADO

CAST IRON CUTTING

IN practice, cast iron cutting differs from steel cutting in that:

(a) It is necessary to use heating flames having an excess of acetylene.

(b) It is necessary to hold the blowpipe nozzle farther away from the metal.

(c) It is necessary to preheat for a longer period for cast iron than for steel, since the cast iron must be almost molten before the cutting reaction will start. Steel ignites at a temperature well below its melting point.

(d) It is necessary to continually oscillate the nozzle to maintain the cut.

Starting a Cast Iron Cut.

A cast iron cut, if properly handled, and if the material is of good quality, will have an appearance about equal to that of a fair cut in steel.

The time required for cutting a given section of cast iron

Completion of Job Above.

is about twice that required for cutting a similar section of steel. This makes the cost considerably higher in the instance of cast iron and tends to restrict its applications in many places where one might suppose it would be generally useful. For example, the inexpensive methods employed for removing risers from castings in iron foundries preclude the use of oxy-acetylene as an economical means of performing this class of work. Further, the cutting off of risers from chilled iron castings is usually not practical because the surfaces cut are likely to crack or check, due to local heating.

The use of cast iron cutting is already being appreciated in the steel mills, where it was introduced more than a year ago. In those plants its demonstration was received enthusiastically, and cast iron cutting has since been used daily in that and other industries for removing broken machinery parts such as pinions, gears, fly-wheels, housings, etc. The removal of such parts by old methods usually required several days because of frozen shafts, bolts and the like. With the cutting torch the broken part, and sometimes parts adjacent to it, are cut quickly, the parts removed, repaired, or new parts installed all within a few hours.

Instructions for Cutting Cast Iron

The blowpipe manipulations for cutting good grades of cast iron and for cutting poor grades of cast iron are quite different and are both described below. Although there is a difference in the manipulation of the torch, the oxygen pressures used and the adjustment of the flame are the same for both grades of metal.

Method for cutting good grades of Cast Iron:

(1) Adjust oxygen cutting regulator to give the correct pressure as shown in the Cast Iron Cutting Chart for the work to be done, having the cutting valve open. Then close cutting valve.

(2) Open oxygen valve one-half turn and acetylene valve fully and light torch. Open cutting valve and adjust acetylene valve to give flames having an excess of acetylene, the length shown in the cutting chart. Then close cutting valve.

(3) Hold torch so that the nozzle points *backward* at an angle of 45 deg., with the inner cones (not the excess cones) ⅛″ to ¼″ above the surface, give the nozzle a swinging motion describing semi-circles over the end of the line of cutting and heat a semi-circular area about ½″ to ¾′ diameter to a bright cherry.

(4) Move nozzle just off the heated edge, open cutting valve quickly and move nozzle (at 45 deg.) forward along the line of the cut with the same swinging motion.

(5) While advancing the nozzle gradually straighten it up so that it is about 75 deg. pointing *backward* when at the inner edge of the previously heated semi-circular area.

(6) Advance nozzle about ¼″ to burn off the molten surface, then quickly move it backward to burn through the comparatively dark layer and lower section, then hold it steady for a moment to heat the upper surface.

This movement can be best practiced by counting as follows: 1 forward, 2 back, 3 hold; 1 forward, 2 back, 3 hold, etc., etc.

(7) Continue moving nozzle in this manner at the rate of about one complete cycle per second.

(8) When the far edge is reached, carry nozzle over the edge and across the other surface, holding it at about the angle of the lag, and cut through the lag section.

Method for Cutting Poor Grades of Cast Iron

Follow the directions given for cutting good grade grey iron, except that instead of using the peculiar motion explained, advance the nozzle slowly, describing semi-circles from about ¼″ to ½″ wide across the line of the cut, holding the torch at about 75 deg. pointing backward.

Notes on Cast Iron Cutting.

In cutting cast iron a dark layer will be found extending down from the top surface about 1″ to 1½″. Below that layer the material will be bright, having an appearnace about the same as steel.

Be sure that the forward and backward, or the semi-circular movement of the nozzle allows the torch to cut almost perpendicularly through the dark layer. The lag must not

Details of the Milburn Suit in Federal Court

ON December 30th, 1920, the Alexander Milburn Company filed suit to recover $2,250,000 damages for alleged violations of the Sherman and Clayton Anti-Trust acts and the Federal Trade Commission act and for alleged unfair methods of competition, against the Union Carbide and Carbon Corporation, of New York, and subsidiary companies:

THE UNION CARBIDE COMPANY
THE UNION CARBIDE SALES COMPANY
OXWELD ACETYLENE COMPANY
LINDE AIR PRODUCTS COMPANY
PREST-O-LITE COMPANY, INC.,
and THE DAVIS-BOURNONVILLE COMPANY

The declaration in the action against the Union Carbide and Carbon Corporation alleges that the concern and its subsidiaries entered into unlawful combinations and conspiracies to eliminate competition and monopolize the industry controlling the manufacture and sale of carbide, oxygen gas, acetylene gas, acetylene generators and apparatus used in the welding and cutting industry. It is also alleged that the concern elected and retained interlocking boards of directors in violation of the anti-trust laws.

The declaration also charges that the conduct of the business of the concern and its subsidiaries is contrary to the common and statute laws, creates a monopoly, unfair methods of competition, directed alike against the public and other manufacturers and dealers in the same line of business.

The declaration charges that the corporation and its subsidiaries or associates, the defendant companies, committed the following acts:

1—Repeated, published and circulated false reports that the Milburn Company would not be able to perform its contracts or properly care for its customers.

2—Made false representations that Milburn apparatus and machinery infringed patents controlled by the corporation or its subsidiaries and threatened to file and did file suits.

3—Demanded and required of the Milburn Company and other manufacturers and dealers the names of their customers, dates of all sales, list of apparatus supplied their customers, dates of shipment and other information before the corporation and its subsidiaries would furnish such users of apparatus with oxygen and acetylene or pay dealers the jobbers commissions thereon.

4—Agreed and conspired to divert and control all sales of Oxy-acetylene and other similar apparatus and appliances to railroad companies so that such business should be handled and controlled by the subsidiaries of the corporation.

5—Agreed and conspired to divert and control the sale of equipment to the army and navy, so that such business should be controlled by one of the defendant companies. That in order to facilitate such control the defendants conspired to secure appointment of their employees by purchasing bureaus of the United States Government.

6—That the corporation and its subsidiaries committed acts against the Milburn Company for the purpose of discrediting it and damaging its reputation for efficiency of its apparatus.

7—That the corporation conspired and contrived to dissuade agents, representatives and employees of the Milburn Company from continuing to act in such employment.

8—That the corporation conspired to control other trade organizations, to obtain modifications of the rules and regulations of the National Board of Fire Underwriters and the Wisconsin Industrial Commission, and to bring about changes in the specifications of the Army and Navy for the use of various gases and apparatus and to use such organizations and associations to discredit Milburn apparatus and equipment.

9—That the corporation conspired to influence the Underwriters' Laboratories to establish rules and regulations injurious to the Milburn Company and to cause delays in the tests of and reports on its apparatus and equipment.

At the same time suit was filed asking $250,000 damages against the Underwriters' Laboratories, Incorporated, of Chicago, alleging damages for failure of the Laboratories to make fair, prompt and accurate reports upon apparatus submitted, with malicious intent to injure the Milburn Company, also preventing the introduction and sale of Milburn apparatus by causing unfair and unreasonable delays in making tests and reports and making them in such a manner as to interfere with the operations of its apparatus.

The declaration further states that the Underwriters' Laboratories discriminated against the Alexander Milburn Company by requiring it to incorporate in its devices certain features not required by other apparatus manufacturers.

Paid advertisement of The Alexander Milburn Company, Baltimore, Md.

start until below that section. Particular attention must be paid to this condition.

If cut is lost, move nozzle back along one edge of the kerf about ½" and describe semi-circles lapping that edge and that point where the cut stopped. If the cut is not readily resumed, carry the semi-circles over to include both edges of the cut and the point where the cut stopped.

Always wear heavy asbestos gloves and suitable clothing to protect the body, face and head, because cast iron cutting is a very much hotter operation than steel cutting.

Always make sure of ample protection from the heat before starting so that it will not be necessary to stop the cutting operation to take shelter or provide further protection.

CAST IRON CUTTING CHART

(Numbers refer to Oxweld torches.)

Size of Nozzle	Thickness of Metal In.	Oxygen Pressure lb. sq. in.	Length of Excess Acetylene in.
No. 3	½	45	1 to 1½
	¾	50	
	1	55	
	1¼	60	
	1½	65	
	1¾	70	
	2	75	
No. 4	3	85	1 to 2
	4	95	
	5	105	
	6	115	
	8	125	
	10	155	
	12	175	

There has been no more interesting recent development in the oxy-acetylene field of research than the successful application of oxygen to the cutting of cast iron. Curiously enough this old enigma of the industry appears to have been solved contemporaneously, if not concurrently, by separate investigators and in entirely different ways. At the present stage of development cast iron cutting may be accepted as an established fact, but not as a concluded study, and the future may be looked to with every confidence that it will yield much of interest and value in the general direction of increased economy and practical utility of the process.

OIL FURNACE HANDLES PREHEATING

Editor:

In our shop we are doing a lot of salvage work on motor castings. In one month we welded 2,800 four cylinder blocks, 4,400 cylinder heads, 1,600 oil pans, 2,400 gear covers, and 900 crank cases, so you can see that we keep busy.

Our work is all preheated in a long oil furnace, going in at one end and coming out to be welded at the other. The welding department is run on three eight-hour shifts. The work is mostly piece work, and the men are discounted for defective welds and cracked castings. Quite a lot of trouble was experienced at first because the men were careless about taking care of the work after it was welded, so now we cover our castings with a box of 16-gauge metal until cool; the ones which have bad welds are buried in sand as an added precaution. Failures averaged about 5 per cent at first but last week out of three hundred cylinder blocks we had only seven that had to be done over.

In the Automotive School of the local Y. M. C. A. is included a night welding course in which I am instructor. The course is a complete one and the Davis-Bournonville apparatus is used. There are torches enough to supply twenty students. The course lasts six weeks and classes meet four nights a week for two hour periods. The time is divided between lectures and shop practice. Steel, cast iron, and aluminum welding, brazing, and general repair work are covered. There is also a course in machine-shop work. The instructors are all men with long and thorough experience.

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This company has one of the best equipped welding plants in the country, having the latest improved apparatus throughout. Oxygen is supplied to the blowpipes through a system of shop piping. The company is estimating now on the gas holders for the new plant of the Linde Air Products Company at New Orleans, and if awarded this contract there will shortly be a new "largest welded tank" to take its rank in the welding field.

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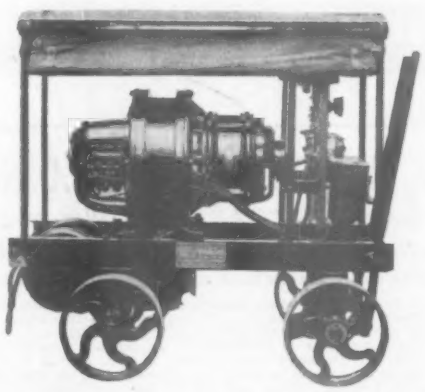

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WELDING NEWS.

Walter Soderling, Inc., 347 West Broadway, New York City, makers of DUSTITE Respirators, announce the sale of all patents, trade marks, machinery and good will to Willson Goggles, Inc. Hereafter, DUSTITE Respirators will be made at the Willson factory in Reading, Pa., under the personal supervision of Mr. Walter Soderling.

The Blaw-Knox Company (Blawnox), Pittsburgh, Pa., has established a new sales district in South, with headquarters at Birmingham, Ala. Prescott V. Kelly, formerly connected with the executive sales department at Pittsburgh, is in charge of this office, which is located in the American Trust building.

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CURRENT WELDING LITERATURE

REACTIONS.—Published by Metal & Thermit Corporation. In this number: Where steam railroads can weld rails advantageously; Repairing a saw mill crankshaft; Repairing an electric locomotive crane base; Welding a fractured rudder frame; Allowing for contraction in frame welding.

PROBLEMS IN PREHEATING, by David Baxter.—A few examples and explanations of where, why, and how to preheat for every-day welding experience. The amount and location of the preheating, and the precautions taken about cooling, are the things that influence the welder's control over contraction. Steam and automobile cylinders are taken as examples.—Acetylene Journal, January.

OXYGEN-HYDROGEN GENERATORS.—Description and illustrations of electrolytic oxygen generating systems, with charts showing production rates and economy features. By International Oxygen Co. Booklet.

AUTOGENOUS WELDING.—House organ of Davis-Bournonville Co. January number contains articles on Torch Flames, Radiagraph Cutting of Heavy Forgings. Reclaiming Drop Forgings, Locomotive Cylinder Welding, Cutting Machines in New York Ship-building Plant, Welding a Brine Cooler, and Cracks in Forgings.

OXY-ACETYLENE WELDING AND CUTTING PROCESSES.—Instruction book issued by Superior Oxy-Acetylene Co. Tells how to set up, operate, and care for equipment, how to weld various metals, tables of flame temperatures, melting points and heat units.

WELDED STEAM PIPES.—High-pressure wrought-iron steam lines being welded in Toronto. Oxy-Acetylene process throws pipe fittings into the discard.—Canadian Welding Journal, December.

HAND BOOK ON OXY-ACETYLENE WELDING.—Issued by Modern Engineering Company. Description of apparatus and instructions for welding and cutting with the oxy-acetylene flame. A feature is the announcement of a new style regulator, which contains four seats instead of one, so that a new seat can be put in place of a broken one by revolving the holder.

ELECTRIC WELDING OF STEEL.—Extract from a paper read by H. S. Rawdon before the A. S. M. E., relating to tests made by the Bureau of Standards. The author concludes that the mechanical properties of an arc weld are dependent to a large degree on the skill, care, and patience of the operator.—The Iron Age, December 16.

OXYGEN CUTTING MACHINE.—Description of a new machine which, by the use of various devices on the torch effects remarkable economy in the consumption of gas and time required for cutting.—Acetylene and Welding Journal, December.

WELDING CAST IRON, by Marcel Piette.—Welding iron castings demands the operator's constant attention and a close study of the contraction and expansion effects that are so dangerous to the strength of the weld. Recommendations are given for procedure in the case of one casting used as an an example.—Revue de la Soudure Autogene, November.

THE ANALYSIS OF CALCIUM CARBIDE.—The author points out the importance of using a specially constructed generator and gives a detailed description, with illustration of the generator type generally adopted in France.—Journal de L'Acetylene, November.

EFFECT OF ULTRA-VIOLET RAYS ON THE EYE.—Out of thirty men recently viewing a demonstration of electric arc welding seventeen reported to the doctor a few hours later. Only two were unaffected and these two wore thick orange-colored goggles. The prevailing complaint was traumatic conjunctivitis. The article describes the symptoms, effect, cure and prevention of this disease.—General Electric Review, November.

WELDING COSTS.—Method of accounting used by the Denver Tramway Company shows that on the average reclamation work the total cost runs somewhere between one and ten per cent of the savings affected.—Electric Traction, December.

THE ART OF WELDING GEARS AND PINIONS, by F. H. Sweet.—Advisability of welding each tooth separately or en bloc depends on particular job. Selection of proper welding tip and filler rod.—Blast Furnace and Steel Plant, December.

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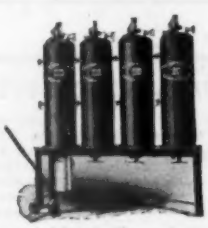

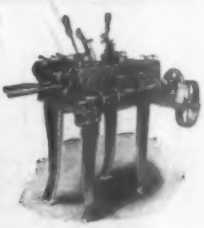

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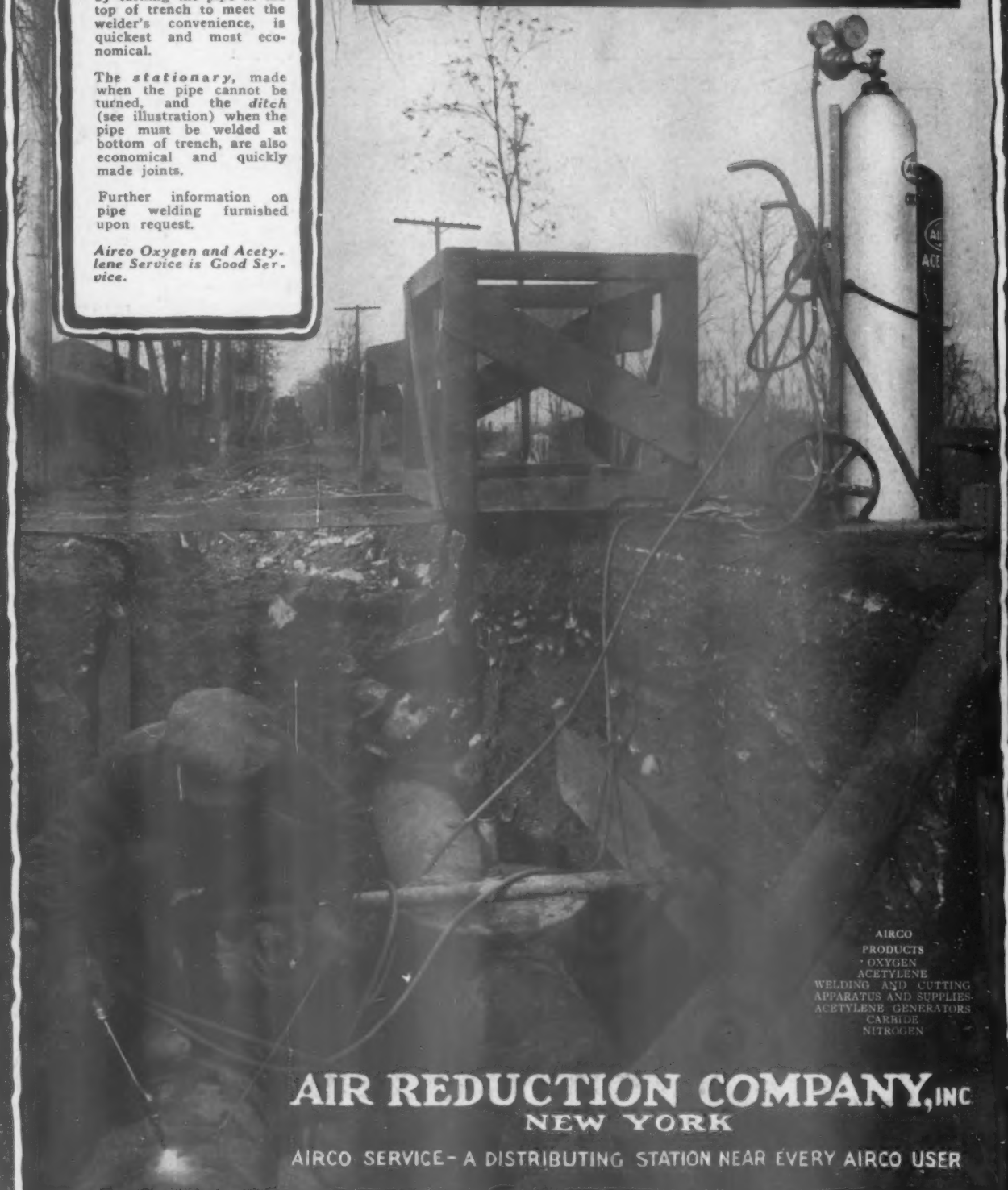

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